(3)

Inquiry on Federal
Water Policy

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APPENDIX A
ALTERNATIVE FUTURES OF CANADIAN WATER USE
1981-2011

by

Donald M. Tate

Canada

Inquiry on Federal Water Policy
Research Paper # 17

APPENDIX A
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May 1985

APPENDIX

ALTERNATIVE FORECASTS OF CANADIAN WATER USE, 1981-2011

Forecasts for Canada, its Regions and Major River Basins

by
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May, 1985

Note: The sum of the river basin water use quantities may not add to the corresponding regional total due to rounding and to minor inaccuracies in the proportions used to break the regional data down into the constituent river basins. In most cases, such errors are under 1% on regional totals.

Appendix

The Appendix contains data for Canada, the British Columbia Region, the Prairie Region, the Ontario region, the Quebec Region, the Atlantic Region and river basins in million cubic metres (MCM) per year. They are tabulated in the following order:

Canada

British Columbia Region

Basin 1 - Pacific Coastal
Basin 2 - Fraser - Lower Mainland
Basin 3 - Okanagan
Basin 4 - Columbia
Basin 5 - Yukon
Basin 6 - Peace-Athabasca River in British Columbia Region

Prairie Region

Basin 6 - Peace-Athabasca River in Prairie Region
Basin 7 - Mackenzie
Basin 8 - Arctic Coastal - no data available *
Basin 9 - Milk
Basin 10 - North Saskatchewan
Basin 11A - Red Deer
Basin 11B - Bow
Basin 11C - Oldman
Basin 11D - South Saskatchewan
Basin 12A - Old Wives Lakes
Basin 12B - Qu'Appelle
Basin 12C - Souris
Basin 12D - Assiniboine
Basin 12E - Pembina
Basin 12F - Red
Basin 13 - Winnipeg River in Prairie Region
Basin 14A - Lower Saskatchewan
Basin 14B - Manitoba Lakes
Basin 14C - Nelson
Basin 15 - Churchill - no data available *
Basin 16 - Keewatin - no data available *

Ontario Region

Basin 13 - Winnipeg River in Ontario Region
Basin 17 - Northern Ontario
Basin 19A - Lake Superior
Basin 19B - Lake Huron
Basin 19C - Lakes St. Clair & Erie
Basin 19D - Lake Ontario & Upper St. Lawrence
Basin 20 - Ottawa River in Ontario Region

* As no data was available for these basins, they were not included.

Quebec Region

Basin 18 - Northern Quebec
Basin 20 - Ottawa River in Quebec Region
Basin 21 - St. Lawrence
Basin 22 - North Shore & Gaspé

Atlantic Region

Basin 23 - Saint John and St. Croix
Basin 24A - New Brunswick Coastal
Basin 24B - Nova Scotia
Basin 24C - Prince Edward Island
Basin 25 - Newfoundland - Labrador

The tables are organized under the following titles:

Summary of Water Intake by Scenario and Year, 1981-2011
Summary of Gross Water Use by Scenario and Year, 1981-2011
Summary of Consumptive Water Use by Scenario and Year, 1981-2011
Summary of Agricultural Water Intake by Scenario and Year, 1981-2011
Summary of Agricultural Gross Water Use by Scenario and Year, 1981-2011
Summary of Agricultural Consumptive Use by Scenario and Year, 1981-2011
Summary of Mineral Extraction Water Intake by Scenario and Year, 1981-2011
Summary of Minteral Extraction Water Use by Scenario and Year, 1981-2011
Summary of Mineral Consumptive Use by Scenario and Year, 1981-2011
Summary of Manufacturing Water Intake by Scenario and Year, 1981-2011
Summary of Manufacturing Gross Water Use by Scenario and Year, 1981-2011
Summary of Manufacturing Consumptive Use by Scenario and Year, 1981-2011
Summary of Power Generation Water Intake by Scenario and Year, 1981-2011
Summary of Power Generation Gross Water Use by Scenario and Year, 1981-2011
Summary of Power Generation Consumptive Use by Scenario and Year, 1981-2011
Summary of Municipal Water Intake by Scenario and Year, 1981-2011
Summary of Municipal Gross Water Use by Scenario and Year, 1981-2011
Summary of Municipal Consumptive Use by Scenario and Year, 1981-2011

The reader is asked to bear in mind that the totals may not add due to rounding.

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
CANADA (MCM/YEAR)

ECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
ricul	3125	3125	3125	3125	3125
neral	648	648	648	648	648
nufact	10201	10201	10201	10201	10201
wer	19281	19281	19281	19281	19281
nicipal	4263	4263	4263	4263	4263
tal	37518	37518	37518	37518	37518
1991					
ricul	3991	3369	3953	3670	4323
neral	912	843	912	810	1030
nufact	12602	10797	13066	11763	13601
wer	24216	22325	27189	22521	25867
nicipal	5157	4514	5391	4877	5454
tal	46878	41848	50511	43641	50275
2001					
ricul	4851	3249	4890	4120	5706
neral	1255	1047	1295	1096	1434
nufact	15954	11122	16998	13583	18695
wer	30906	25805	37442	27519	34482
nicipal	5931	4366	6597	5281	6694
tal	58897	45589	67222	51599	67011
2011					
ricul	5897	2800	5996	4561	7113
neral	1733	1279	1925	1382	1840
nufact	20274	10501	22426	15167	23814
wer	39558	29174	52074	31947	43267
nicipal	6869	3984	8458	5662	8005
tal	74331	47738	90879	58719	84039

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011, CANADA (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	3125	3125	3125	3125	3125
Mineral	3440	3440	3440	3440	3440
Manufact	21459	21459	21459	21459	21459
Power	21149	21149	21149	21149	21149
Municipal	4263	4263	4263	4263	4263
Total	53436	53436	53436	53436	53436
1991					
Agricul	3991	3369	3953	3670	4323
Mineral	4659	4294	4944	4103	5282
Manufact	26699	22813	27470	24855	28791
Power	26648	24571	30030	24768	28499
Municipal	5157	4514	5391	4877	5454
Total	67154	59561	71788	62273	72349
2001					
Agricul	4851	3249	4890	4120	5706
Mineral	6380	5329	7387	5564	7245
Manufact	33966	23515	35813	28712	39867
Power	34101	28472	41553	30352	38083
Municipal	5931	4366	6597	5281	6694
Total	85229	64931	96240	74029	97595
2011					
Agricul	5897	2800	5996	4561	7113
Mineral	8777	6473	11768	7026	9192
Manufact	43412	22175	47429	32107	51066
Power	43762	32278	58090	35290	47872
Municipal	6869	3984	8458	5662	8005
Total	108717	67710	131741	84646	123248

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
CANADA (MCM/YEAR)

ECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
gricul	2412	2412	2412	2412	2412
ineral	179	179	179	179	179
anufact	507	507	507	507	507
ower	168	168	168	168	168
unicipal	640	640	640	640	640
otal	3906	3906	3906	3906	3906
1991					
gricul	3089	2629	3058	2837	3345
ineral	237	220	245	210	268
anufact	639	578	665	522	685
ower	209	196	233	174	225
unicipal	737	669	776	698	775
otal	4911	4292	4977	4441	5298
2001					
gricul	3756	2516	3787	3188	4416
ineral	320	267	346	273	368
anufact	812	583	900	683	961
ower	269	225	334	241	301
unicipal	851	621	952	756	944
otal	6008	4212	6319	5141	6990
2011					
gricul	4567	2168	4647	3533	5809
ineral	433	320	509	336	467
anufact	1038	571	1213	758	1247
ower	349	258	475	281	378
unicipal	976	565	1230	813	1124
otal	7363	3882	8074	5721	9025

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
CANADA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3125	3125	3125	3125	3125
1991	3991	3369	3953	3670	4323
2001	4851	3249	4890	4120	5706
2011	5897	2800	5996	4561	7113

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
CANADA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3125	3125	3125	3125	3125
1991	3991	3369	3953	3670	4323
2001	4851	3249	4890	4120	5706
2011	5897	2800	5996	4561	7113

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
CANADA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2412	2412	2412	2412	2412
1991	3089	2629	3058	2837	3345
2001	3756	2516	3787	3188	4416
2011	4567	2168	4647	3533	5809

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
CANADA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	648	648	648	648	648
1991	912	843	912	810	1030
2001	1255	1047	1295	1096	1434
2011	1733	1279	1925	1382	1840

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
CANADA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3440	3440	3440	3440	3440
1991	4659	4294	4944	4103	5282
2001	6380	5329	7387	5564	7245
2011	8777	6473	11768	7026	9192

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
CANADA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	179	179	179	179	179
1991	237	220	245	210	268
2001	320	267	346	273	368
2011	433	320	509	336	467

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
CANADA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	10201	10201	10201	10201	10201
1991	12602	10797	13066	11763	13601
2001	15954	11122	16998	13583	18695
2011	20274	10501	22426	15167	23814

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
CANADA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	21459	21459	21459	21459	21459
1991	26699	22813	27470	24855	28791
2001	33966	23515	35813	28712	39867
2011	43412	22175	47429	32107	51066

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
CANADA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	507	507	507	507	507
1991	639	578	665	522	685
2001	812	583	900	683	961
2011	1038	571	1213	758	1247

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
CANADA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	19381	19381	19381	19381	19381
1991	24216	22325	27189	22521	25867
2001	30906	25805	37442	27519	34482
2011	39558	29174	52074	31947	43267

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
CANADA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	21249	21249	21249	21249	21249
1991	26648	24571	30030	24768	28499
2001	34101	28472	41553	30352	38083
2011	43762	32278	58090	35290	47872

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
CANADA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	168	168	168	168	168
1991	209	196	233	174	225
2001	269	225	334	241	301
2011	349	258	475	281	378

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
CANADA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4263	4263	4263	4263	4263
1991	5157	4514	5391	4877	5454
2001	5931	4366	6597	5281	6694
2011	6869	3984	8458	5662	8005

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
CANADA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4263	4263	4263	4263	4263
1991	5157	4514	5391	4877	5454
2001	5931	4366	6597	5281	6694
2011	6869	3984	8458	5662	8005

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
CANADA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	640	640	640	640	640
1991	737	669	776	698	775
2001	851	621	952	756	944
2011	976	565	1230	813	1124

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
B.C. REGION (MCM/YEAR)

ECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
gricul	545	545	545	545	545
ineral	135	135	135	135	135
anufact	2192	2192	2192	2192	2192
ower	360	360	360	360	360
unicipal	558	558	558	558	558
otal	3789	3789	3789	3789	3789
1991					
gricul	660	557	660	621	715
ineral	239	221	238	210	272
anufact	2598	2180	2649	2387	2869
ower	435	401	496	409	466
unicipal	674	590	754	631	720
otal	4608	3950	4798	4257	5043
2001					
ricul	793	531	793	683	932
neral	351	293	349	304	402
nufact	3211	2120	3344	2720	3771
wer	554	462	691	496	615
nicipal	791	582	1009	694	902
tal	5700	3989	6186	4897	6623
2011					
ricul	952	452	952	742	1148
neral	515	380	515	399	534
nufact	3976	1830	4282	3012	4538
wer	707	521	979	572	757
nicipal	935	542	1448	756	1080
tal	7085	3726	8177	5481	8057

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011, B.C. REGION (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	545	545	545	545	545
Mineral	488	488	488	488	488
Manufact	4901	4901	4901	4901	4901
Power	360	360	360	360	360
Municipal	558	558	558	558	558
Total	6851	6851	6851	6851	6851
1991					
Agricul	660	557	660	621	715
Mineral	861	794	857	755	980
Manufact	5855	4927	5933	5429	6375
Power	435	401	496	409	466
Municipal	674	590	754	631	720
Total	8486	7269	8701	7845	9256
2001					
Agricul	793	531	793	683	932
Mineral	1258	1051	1255	1090	1446
Manufact	7291	4848	7505	6126	8596
Power	554	462	691	496	615
Municipal	791	582	1009	694	902
Total	10687	7474	11252	9088	12491
2011					
Agricul	952	452	952	742	1148
Mineral	1843	1359	1847	1426	1918
Manufact	9094	4252	9604	6736	10483
Power	707	521	979	572	757
Municipal	935	542	1448	756	1080
Total	13531	7127	14831	10232	15386

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR, 1981-2011, B.C. REGION (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	304	304	304	304	304
Mineral	15	15	15	15	15
Manufact	66	66	66	66	66
Power	18	18	18	18	18
Municipal	84	84	84	84	84
Total	487	487	487	487	487
1991					
Agricul	369	311	369	347	400
Mineral	26	24	26	23	30
Manufact	80	68	81	76	84
Power	22	20	25	20	23
Municipal	101	88	113	95	108
Total	598	512	614	561	645
2001					
Agricul	443	297	443	381	520
Mineral	38	32	39	33	44
Manufact	101	68	104	84	119
Power	28	23	35	25	31
Municipal	119	87	151	104	135
Total	729	508	772	628	850
2011					
Agricul	532	253	532	414	641
Mineral	56	42	57	44	59
Manufact	129	62	136	91	146
Power	35	26	49	29	38
Municipal	140	81	217	113	162
Total	893	464	991	691	1046

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
B.C. REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	545	545	545	545	545
1991	660	557	660	621	715
2001	793	531	793	683	932
2011	952	452	952	742	1148

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
B.C. REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	545	545	545	545	545
1991	660	557	660	621	715
2001	793	531	793	683	932
2011	952	452	952	742	1148

SUMMARY OF AGRICULTURAL WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
B.C. REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	304	304	304	304	304
1991	369	311	369	347	400
2001	443	297	443	381	520
2011	532	253	532	414	641

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
B.C. REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	135	135	135	135	135
1991	239	221	238	210	272
2001	351	293	349	304	402
2011	515	380	515	399	534

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
B.C. REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	488	488	488	488	488
1991	861	794	857	755	980
2001	1258	1051	1255	1090	1446
2011	1843	1359	1847	1426	1918

SUMMARY OF MINERAL EXTRACTION WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-20
B.C. REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	15	15	15	15	15
1991	26	24	26	23	30
2001	38	32	39	33	44
2011	56	42	57	44	59

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
B.C. REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2192	2192	2192	2192	2192
1991	2598	2180	2649	2387	2869
2001	3211	2120	3344	2720	3771
2011	3976	1830	4282	3012	4538

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
B.C. REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4901	4901	4901	4901	4901
1991	5855	4927	5933	5429	6375
2001	7291	4848	7505	6126	8596
2011	9094	4252	9604	6736	10483

SUMMARY OF MANUFACTURING WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
B.C. REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	66	66	66	66	66
1991	80	68	81	76	84
2001	101	68	104	84	119
2011	129	62	136	91	146

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
B.C. REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	360	360	360	360	360
1991	435	401	496	409	466
2001	554	462	691	496	615
2011	707	521	979	572	757

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
.C. REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	360	360	360	360	360
1991	435	401	496	409	466
2001	554	462	691	496	615
2011	707	521	979	572	757

UMMARY OF POWER GENERATION WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
.C. REGION (MCM/YEAR)

EAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	18	18	18	18	18
1991	22	20	25	20	23
2001	28	23	35	25	31
2011	35	26	49	29	38

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
B.C. REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	558	558	558	558	558
1991	674	590	754	631	720
2001	791	582	1009	694	902
2011	935	542	1448	756	1080

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
B.C. REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	558	558	558	558	558
1991	674	590	754	631	720
2001	791	582	1009	694	902
2011	935	542	1448	756	1080

SUMMARY OF MUNICIPAL WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
B.C. REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	84	84	84	84	84
1991	101	88	113	95	108
2001	119	87	151	104	135
2011	140	81	217	113	162

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 1 - PACIFIC COASTAL (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	32	32	32	32	32
Manufact	1632	1632	1632	1632	1632
Power	360	360	360	360	360
Municipal	102	102	102	102	102
Total	2126	2126	2126	2126	2126
1991					
Agricul	0	0	0	0	0
Mineral	57	53	56	50	65
Manufact	1927	1611	1950	1759	2142
Power	435	401	496	409	466
Municipal	123	108	139	116	132
Total	2543	2173	2642	2334	2805
2001					
Agricul	[illegible]	0	0	0	0
Mineral	84	70	83	73	96
Manufact	2369	1549	2431	2013	2778
Power	554	462	691	496	615
Municipal	145	107	188	128	164
Total	3152	2188	3392	2710	3653
2011					
Agricul	0	0	0	0	0
Mineral	123	91	122	96	128
Manufact	2920	1314	3060	2238	3317
Power	707	521	979	572	757
Municipal	172	100	273	140	196
Total	3922	2025	4434	3045	4398

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 1 - PACIFIC COASTAL (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	89	89	89	89	89
Manufact	3201	3201	3201	3201	3201
Power	360	360	360	360	360
Municipal	102	102	102	102	102
Total	3751	3751	3751	3751	3751
1991					
Agricul	0	0	0	0	0
Mineral	159	146	157	139	181
Manufact	3810	3194	3834	3534	4160
Power	435	401	496	409	466
Municipal	123	108	139	116	132
Total	4528	3850	4627	4197	4938
2001					
Agricul	0	0	0	0	0
Mineral	233	195	230	202	267
Manufact	4738	3119	4807	3996	5549
Power	554	462	691	496	615
Municipal	145	107	188	128	164
Total	5669	3883	5917	4822	6595
2011					
Agricul	0	0	0	0	0
Mineral	343	253	338	266	355
Manufact	5901	2698	6071	4393	6673
Power	707	521	979	572	757
Municipal	172	100	273	140	196
Total	7122	3572	7661	5371	7982

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 1 - PACIFIC COASTAL (MCM/YEAR)

CTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
ricul	0	0	0	0	0
neral	0	0	0	0	0
nufact	36	36	36	36	36
wer	18	18	18	18	18
nicipal	15	15	15	15	15
tal	69	69	69	69	69
1991					
ricul	0	0	0	0	0
neral	0	0	0	0	0
nufact	44	37	44	42	46
wer	22	20	25	20	23
nicipal	18	16	21	17	20
tal	84	73	90	80	89
2001					
ricul	0	0	0	0	0
neral	0	0	0	0	0
nufact	56	37	56	46	65
wer	28	23	35	25	31
nicipal	22	16	28	19	25
tal	106	76	119	90	120
2011					
ricul	0	0	0	0	0
neral	0	0	0	0	0
nufact	71	34	72	50	79
wer	35	26	49	29	38
nicipal	26	15	41	21	29
tal	132	75	162	99	147

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 1 - PACIFIC COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 1 - PACIFIC COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF AGRICULTURAL WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 1 - PACIFIC COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 1 - PACIFIC COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	32	32	32	32	32
1991	57	53	56	50	65
2001	84	70	83	73	96
2011	123	91	122	96	128

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-201
BASIN 1 - PACIFIC COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	89	89	89	89	89
1991	159	146	157	139	181
2001	233	195	230	202	267
2011	343	253	338	266	355

SUMMARY OF MINERAL EXTRACTION WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2
BASIN 1 - PACIFIC COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 1 - PACIFIC COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1632	1632	1632	1632	1632
1991	1927	1611	1950	1759	2142
2001	2369	1549	2431	2013	2778
2011	2920	1314	3060	2238	3317

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 1 - PACIFIC COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3201	3201	3201	3201	3201
1991	3810	3194	3834	3534	4160
2001	4738	3119	4807	3996	5549
2011	5901	2698	6071	4393	6673

SUMMARY OF MANUFACTURING WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 1 - PACIFIC COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	36	36	36	36	36
1991	44	37	44	42	46
2001	56	37	56	46	65
2011	71	34	72	50	79

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 1 - PACIFIC COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	360	360	360	360	360
1991	435	401	496	409	466
2001	554	462	691	496	615
2011	707	521	979	572	757

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 1 - PACIFIC COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	360	360	360	360	360
1991	435	401	496	409	466
2001	554	462	691	496	615
2011	707	521	979	572	757

SUMMARY OF POWER GENERATION WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 1 - PACIFIC COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	18	18	18	18	18
1991	22	20	25	20	23
2001	28	23	35	25	31
2011	35	26	49	29	38

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 1 - PACIFIC COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	102	102	102	102	102
1991	123	108	139	116	132
2001	145	107	188	128	164
2011	172	100	273	140	196

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 1 - PACIFIC COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	102	102	102	102	102
1991	123	108	139	116	132
2001	145	107	188	128	164
2011	172	100	273	140	196

SUMMARY OF MUNICIPAL WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 1 - PACIFIC COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	15	15	15	15	15
1991	18	16	21	17	20
2001	22	16	28	19	25
2011	26	15	41	21	29

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 2 - FRASER - LOWER MAINLAND (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	258	258	258	258	258
Mineral	51	51	51	51	51
Manufact	263	263	263	263	263
Power	0	0	0	0	0
Municipal	380	380	380	380	380
Total	952	952	952	952	952
1991					
Agricul	313	264	313	294	339
Mineral	91	84	90	80	104
Manufact	314	267	327	300	330
Power	0	0	0	0	0
Municipal	458	401	511	429	490
Total	1176	1016	1240	1103	1263
2001					
Agricul	375	252	375	323	441
Mineral	134	112	132	116	153
Manufact	395	270	430	335	459
Power	0	0	0	0	0
Municipal	538	396	679	471	615
Total	1442	1029	1616	1244	1668
2011					
Agricul	451	214	451	351	543
Mineral	196	145	194	152	203
Manufact	498	246	578	363	563
Power	0	0	0	0	0
Municipal	635	368	969	512	737
Total	1780	974	2193	1378	2047

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011,
BASIN 2 - FRASER - LOWER MAINLAND (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	258	258	258	258	258
Mineral	256	256	256	256	256
Manufact	1315	1315	1315	1315	1315
Power	0	0	0	0	0
Municipal	380	380	380	380	380
Total	2208	2208	2208	2208	2208
1991					
Agricul	313	264	313	294	339
Mineral	457	421	452	400	520
Manufact	1586	1343	1616	1473	1709
Power	0	0	0	0	0
Municipal	458	401	511	429	490
Total	2814	2430	2891	2597	3059
2001					
Agricul	375	252	375	323	441
Mineral	671	560	662	582	769
Manufact	1980	1339	2062	1649	2362
Power	0	0	0	0	0
Municipal	538	396	679	471	615
Total	3564	2546	3778	3025	4186
2011					
Agricul	451	214	451	351	543
Mineral	986	727	973	765	1020
Manufact	2475	1200	2670	1811	2961
Power	0	0	0	0	0
Municipal	635	368	969	512	737
Total	4546	2509	5063	3438	5262

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR, 1981-2011, BASIN 2 - FRASER RIVER (MCM/YEAR)

ECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
gricul	144	144	144	144	144
ineral	0	0	0	0	0
anufact	18	18	18	18	18
ower	0	0	0	0	0
unicipal	57	57	57	57	57
otal	219	219	219	219	219
1991					
gricul	175	147	175	164	189
ineral	0	0	0	0	0
anufact	21	18	22	20	22
ower	0	0	0	0	0
unicipal	69	60	77	64	74
otal	264	225	273	248	285
2001					
gricul	210	140	210	181	246
ineral	0	0	0	0	0
anufact	26	18	28	22	31
ower	0	0	0	0	0
unicipal	81	59	102	71	92
otal	317	218	340	273	370
2011					
gricul	252	120	252	196	304
ineral	0	0	0	0	0
anufact	34	16	38	24	39
ower	0	0	0	0	0
unicipal	95	55	145	77	111
otal	381	191	435	297	453

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 2 - FRASER - LOWER MAINLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	258	258	258	258	258
1991	313	264	313	294	339
2001	375	252	375	323	441
2011	451	214	451	351	543

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 2 - FRASER - LOWER MAINLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	258	258	258	258	258
1991	313	264	313	294	339
2001	375	252	375	323	441
2011	451	214	451	351	543

SUMMARY OF AGRICULTURAL WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 2 - FRASER - LOWER MAINLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	144	144	144	144	144
1991	175	147	175	164	189
2001	210	140	210	181	246
2011	252	120	252	196	304

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 2 - FRASER - LOWER MAINLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	51	51	51	51	51
1991	91	84	90	80	104
2001	134	112	132	116	153
2011	196	145	194	152	203

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-20
BASIN 2 - FRASER - LOWER MAINLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	256	256	256	256	256
1991	457	421	452	400	520
2001	671	560	662	582	769
2011	986	727	973	765	1020

SUMMARY OF MINERAL EXTRACTION WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2
BASIN 2 - FRASER - LOWER MAINLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 2 - FRASER - LOWER MAINLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	263	263	263	263	263
1991	314	267	327	300	330
2001	395	270	430	335	459
2011	498	246	578	363	563

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 2 - FRASER - LOWER MAINLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1315	1315	1315	1315	1315
1991	1586	1343	1616	1473	1709
2001	1980	1339	2062	1649	2362
2011	2475	1200	2670	1811	2961

SUMMARY OF MANUFACTURING WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 2 - FRASER - LOWER MAINLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	18	18	18	18	18
1991	21	18	22	20	22
2001	26	18	28	22	31
2011	34	16	38	24	39

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 2 - FRASER - LOWER MAINLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 2 - FRASER - LOWER MAINLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 2 - FRASER - LOWER MAINLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 2 - FRASER - LOWER MAINLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	380	380	380	380	380
1991	458	401	511	429	490
2001	538	396	679	471	615
2011	635	368	969	512	737

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 2 - FRASER - LOWER MAINLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	380	380	380	380	380
1991	458	401	511	429	490
2001	538	396	679	471	615
2011	635	368	969	512	737

SUMMARY OF MUNICIPAL WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 2 - FRASER - LOWER MAINLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	57	57	57	57	57
1991	69	60	77	64	74
2001	81	59	102	71	92
2011	95	55	145	77	111

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 3 - OKANAGAN (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	254	254	254	254	254
Mineral	19	19	19	19	19
Manufact	7	7	7	7	7
Power	0	0	0	0	0
Municipal	29	29	29	29	29
Total	309	309	309	309	309
1991					
Agricul	308	260	308	290	334
Mineral	34	31	34	30	39
Manufact	8	7	9	8	9
Power	0	0	0	0	0
Municipal	35	31	40	33	38
Total	385	329	390	360	419
2001					
Agricul	370	248	370	318	435
Mineral	50	42	49	43	57
Manufact	10	7	11	9	11
Power	0	0	0	0	0
Municipal	42	31	55	37	47
Total	471	327	484	407	550
2011					
Agricul	444	211	444	346	535
Mineral	73	54	72	57	76
Manufact	12	6	14	9	13
Power	0	0	0	0	0
Municipal	49	29	80	40	56
Total	578	300	611	452	681

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011, BASIN 3 - OKANAGAN (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	254	254	254	254	254
Mineral	33	33	33	33	33
Manufact	9	9	9	9	9
Power	0	0	0	0	0
Municipal	29	29	29	29	29
Total	325	325	325	325	325
1991					
Agricul	308	260	308	290	334
Mineral	59	54	58	52	67
Manufact	11	9	11	10	11
Power	0	0	0	0	0
Municipal	35	31	40	33	38
Total	413	355	418	385	450
2001					
Agricul	370	248	370	318	435
Mineral	86	72	85	75	99
Manufact	13	9	15	12	15
Power	0	0	0	0	0
Municipal	42	31	55	37	47
Total	511	360	524	442	596
2011					
Agricul	444	211	444	346	535
Mineral	127	94	125	99	132
Manufact	16	9	19	13	18
Power	0	0	0	0	0
Municipal	49	29	80	40	56
Total	636	342	669	497	741

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 3 - OKANAGAN (MCM/YEAR)

CTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
ricul	142	142	142	142	142
neral	0	0	0	0	0
nufact	0	0	0	0	0
wer	0	0	0	0	
nicipal	4	4	4	4	4
tal	146	146	146	146	146
1991					
ricul	172	145	172	162	186
neral	0	0	0	0	0
nufact	0	0	0	0	0
wer	0	0	0	0	0
nicipal	5	5	6	5	6
tal	177	150	178	167	192
2001					
ricul	207	138	207	178	243
neral	0	0	0	0	0
nufact	0	0	0	0	0
wer	0	0	0	0	0
nicipal	6	5	8	6	7
tal	213	143	215	183	250
2011					
ricul	248	118	248	193	299
neral	0	0	0	0	0
nufact	0	0	0	0	0
wer	0	0	0	0	0
nicipal	7	4	12	6	8
tal	256	122	260	199	307

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 3 - OKANAGAN (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	254	254	254	254	254
1991	308	260	308	290	334
2001	370	248	370	318	435
2011	444	211	444	346	535

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 3 - OKANAGAN (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	254	254	254	254	254
1991	308	260	308	290	334
2001	370	248	370	318	435
2011	444	211	444	346	535

SUMMARY OF AGRICULTURAL WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 3 - OKANAGAN (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	142	142	142	142	142
1991	172	145	172	162	186
2001	207	138	207	178	243
2011	248	118	248	193	299

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 3 - OKANAGAN (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	19	19	19	19	19
1991	34	31	34	30	39
2001	50	42	49	43	57
2011	73	54	72	57	76

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-20
BASIN 3 - OKANAGAN (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	33	33	33	33	33
1991	59	54	58	52	67
2001	86	72	85	75	99
2011	127	94	125	99	132

SUMMARY OF MINERAL EXTRACTION WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-
BASIN 3 - OKANAGAN (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 3 - OKANAGAN (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	7	7	7	7	7
1991	8	7	9	8	9
2001	10	7	11	9	11
2011	12	6	14	9	13

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 3 - OKANAGAN (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	9	9	9	9	9
1991	11	9	11	10	11
2001	13	9	15	12	15
2011	16	9	19	13	18

SUMMARY OF MANUFACTURING WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 3 - OKANAGAN (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 3 - OKANAGAN (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 3 - OKANAGAN (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 3 - OKANAGAN (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 3 - OKANAGAN (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	29	29	29	29	29
1991	35	31	40	33	38
2001	42	31	55	37	47
2011	49	29	80	40	56

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 3 - OKANAGAN (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	29	29	29	29	29
1991	35	31	40	33	38
2001	42	31	55	37	47
2011	49	29	80	40	56

SUMMARY OF MUNICIPAL WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 3 - OKANAGAN (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4	4	4	4	4
1991	5	5	6	5	6
2001	6	5	8	6	7
2011	7	4	12	6	8

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 4 - COLUMBIA RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	33	33	33	33	33
Mineral	15	15	15	15	15
Manufact	219	219	219	219	219
Power	0	0	0	0	0
Municipal	36	36	36	36	36
Total	303	303	303	303	303
1991					
Agricul	40	34	40	38	43
Mineral	27	25	26	23	30
Manufact	260	219	266	240	285
Power	0	0	0	0	0
Municipal	44	38	49	41	47
Total	371	315	382	342	406
2001					
Agricul	48	32	48	41	57
Mineral	39	33	39	34	45
Manufact	323	214	337	273	378
Power	0	0	0	0	0
Municipal	51	38	67	45	58
Total	461	317	491	394	538
2011					
Agricul	58	27	58	45	70
Mineral	58	43	57	45	60
Manufact	401	186	433	301	455
Power	0	0	0	0	0
Municipal	61	35	98	50	69
Total	577	292	646	441	654

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 4 - COLUMBIA RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	33	33	33	33	33
Mineral	17	17	17	17	17
Manufact	285	285	285	285	285
Power	0	0	0	0	0
Municipal	36	36	36	36	36
Total	371	371	371	371	371
1991					
Agricul	40	34	40	38	43
Mineral	30	28	30	27	35
Manufact	335	283	350	312	364
Power	0	0	0	0	0
Municipal	44	38	49	41	47
Total	449	382	469	418	488
2001					
Agricul	48	32	48	41	57
Mineral	45	37	44	39	51
Manufact	416	278	454	355	483
Power	0	0	0	0	0
Municipal	51	38	67	45	58
Total	560	385	613	480	649
2011					
Agricul	58	27	58	45	70
Mineral	65	48	65	51	68
Manufact	517	244	605	392	583
Power	0	0	0	0	0
Municipal	61	35	98	50	69
Total	701	355	825	538	790

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 4 - COLUMBIA RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	18	18	18	18	18
Mineral	0	0	0	0	0
Manufact	9	9	9	9	9
Power	0	0	0	0	0
Municipal	5	5	5	5	5
Total	33	33	33	33	33
1991					
Agricul	22	19	22	21	24
Mineral	0	0	0	0	0
Manufact	11	10	11	11	12
Power	0	0	0	0	0
Municipal	7	6	7	6	7
Total	40	34	41	38	43
2001					
Agricul	27	18	27	23	32
Mineral	0	0	0	0	0
Manufact	14	10	14	12	17
Power	0	0	0	0	0
Municipal	8	6	10	7	9
Total	49	33	51	42	57
2011					
Agricul	32	15	32	25	39
Mineral	0	0	0	0	0
Manufact	18	9	18	13	21
Power	0	0	0	0	0
Municipal	9	5	15	7	10
Total	60	29	65	45	70

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 4 - COLUMBIA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	33	33	33	33	33
1991	40	34	40	38	43
2001	48	32	48	41	57
2011	58	27	58	45	70

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 4 - COLUMBIA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	33	33	33	33	33
1991	40	34	40	38	43
2001	48	32	48	41	57
2011	58	27	58	45	70

SUMMARY OF AGRICULTURAL WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 4 - COLUMBIA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	18	18	18	18	18
1991	22	19	22	21	24
2001	27	18	27	23	32
2011	32	15	32	25	39

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 4 - COLUMBIA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	15	15	15	15	15
1991	27	25	26	23	30
2001	39	33	39	34	45
2011	58	43	57	45	60

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2
BASIN 4 - COLUMBIA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	17	17	17	17	17
1991	30	28	30	27	35
2001	45	37	44	39	51
2011	65	48	65	51	68

SUMMARY OF MINERAL EXTRACTION WATER CONSUMPTION BY SCENARIO AND YEAR, 198
BASIN 4 - COLUMBIA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 4 - COLUMBIA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	219	219	219	219	219
1991	260	219	266	240	285
2001	323	214	337	273	378
2011	401	186	433	301	455

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 4 - COLUMBIA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	285	285	285	285	285
1991	335	283	350	312	364
2001	416	278	454	355	483
2011	517	244	605	392	583

SUMMARY OF MANUFACTURING WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 4 - COLUMBIA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	9	9	9	9	9
1991	11	10	11	11	12
2001	14	10	14	12	17
2011	18	9	18	13	21

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 4 - COLUMBIA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 4 - COLUMBIA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 4 - COLUMBIA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 4 - COLUMBIA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	36	36	36	36	36
1991	44	38	49	41	47
2001	51	38	67	45	58
2011	61	35	98	50	69

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 4 - COLUMBIA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	36	36	36	36	36
1991	44	38	49	41	47
2001	51	38	67	45	58
2011	61	35	98	50	69

SUMMARY OF MUNICIPAL WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 4 - COLUMBIA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	5	5	5	5	5
1991	7	6	7	6	7
2001	8	6	10	7	9
2011	9	5	15	7	10

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 5 - YUKON RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	10	10	10	10	10
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	5	5	5	5	5
Total	15	15	15	15	15
1991					
Agricul	0	0	0	0	0
Mineral	18	16	18	16	20
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	6	5	7	6	7
Total	24	22	24	21	27
2001					
Agricul	0	0	0	0	0
Mineral	26	22	26	23	30
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	7	5	9	6	8
Total	33	27	35	29	38
2011					
Agricul	0	0	0	0	0
Mineral	39	28	38	30	40
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	9	5	13	7	10
Total	47	33	51	37	50

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011, BASIN 5 - YUKON RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	14	14	14	14	14
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	5	5	5	5	5
Total	19	19	19	19	19
1991					
Agricul	0	0	0	0	0
Mineral	25	23	25	22	28
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	6	5	7	6	7
Total	31	28	32	28	35
2001					
Agricul	0	0	0	0	0
Mineral	37	31	36	32	42
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	7	5	9	6	8
Total	44	36	45	38	50
2011					
Agricul	0	0	0	0	0
Mineral	54	40	53	42	56
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	9	5	13	7	10
Total	62	45	66	49	66

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 5 - YUKON RIVER (MCM/YEAR)

ECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
gricul	0	0	0	0	0
ineral	0	0	0	0	0
anufact	0	0	0	0	0
ower	0	0	0	0	0
unicipal	1	1	1	1	1
otal	1	1	1	1	1
1991					
gricul	0	0	0	0	0
ineral	0	0	0	0	0
anufact	0	0	0	0	0
ower	0	0	0	0	0
unicipal	1	1	1	1	1
otal	1	1	1	1	1
2001					
gricul	0	0	0	0	0
ineral	0	0	0	0	0
anufact	0	0	0	0	0
ower	0	0	0	0	0
unicipal	1	1	1	1	1
otal	1	1	1	1	1
2011					
gricul	0	0	0	0	0
ineral	0	0	0	0	0
anufact	0	0	0	0	0
ower	0	0	0	0	0
unicipal	1	1	2	1	1
otal	1	1	2	1	1

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 5 - YUKON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 5 - YUKON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF AGRICULTURAL WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 5 - YUKON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 5 - YUKON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	10	10	10	10	10
1991	18	16	18	16	20
2001	26	22	26	23	30
2011	39	28	38	30	40

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-20
BASIN 5 - YUKON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	14	14	14	14	14
1991	25	23	25	22	28
2001	37	31	36	32	42
2011	54	40	53	42	56

SUMMARY OF MINERAL EXTRACTION WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-
BASIN 5 - YUKON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 5 - YUKON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 5 - YUKON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 5 - YUKON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 5 - YUKON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 5 - YUKON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 5 - YUKON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 5 - YUKON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	5	5	5	5	5
1991	6	5	7	6	7
2001	7	5	9	6	8
2011	9	5	13	7	10

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 5 - YUKON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	5	5	5	5	5
1991	6	5	7	6	7
2001	7	5	9	6	8
2011	9	5	13	7	10

SUMMARY OF MUNICIPAL WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 5 - YUKON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	1	1	1	1	1
2011	1	1	2	1	1

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN THE BRITISH COLUMBIA REGION

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	60	60	60	60	60
Power	0	0	0	0	0
Municipal	6	6	6	6	6
Total	66	66	66	66	66
1991					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	77	66	84	68	87
Power	0	0	0	0	0
Municipal	7	6	8	7	8
Total	84	72	92	75	95
2001					
Agricul	0	0	0	0	[illegible]
Mineral	0	0	0	0	[illegible]
Manufact	97	68	117	77	121
Power	0	0	0	[illegible]	[illegible]
Municipal	8	6	11	7	[illegible]
Total	105	74	127	85	131
2011					
Agricul	0	0	0	0	[illegible]
Mineral	0	0	0	0	[illegible]
Manufact	122	65	170	86	155
Power	0	0	0	0	[illegible]
Municipal	10	6	15	8	12
Total	132	70	185	94	167

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 6 - PEACE-ATHABASCA RIVER IN BRITISH COLUMBIA REGION

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	61	61	61	61	61
Power	0	0	0	0	0
Municipal	6	6	6	6	6
Total	67	67	67	67	67
1991					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	78	67	85	69	89
Power	0	0	0	0	0
Municipal	7	6	8	7	8
Total	85	73	93	76	96
2001					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	98	69	118	78	123
Power	0	0	0	0	0
Municipal	8	6	11	7	10
Total	107	75	129	86	133
2011					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	124	66	172	87	158
Power	0	0	0	0	0
Municipal	10	6	15	8	12
Total	134	71	188	95	169

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR, 1981-2011, BASIN 6 - PEACE-ATHABASKA RIVER IN B.C. (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	1	1	1	1	1
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	2	2	2	2	2
1991					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	1	1	1	1	1
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	2	2	2	2	2
2001					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	2	1	2	1	2
Power	0	0	0	0	0
Municipal	1	1	2	1	1
Total	3	2	4	2	3
2011					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	2	1	3	1	2
Power	0	0	0	0	0
Municipal	1	1	2	1	2
Total	3	2	5	2	4

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN THE BRITISH COLUMBIA REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN THE BRITISH COLUMBIA REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF AGRICULTURAL WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN THE BRITISH COLUMBIA REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN THE BRITISH COLUMBIA REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-201
BASIN 6 - PEACE-ATHABASCA RIVER IN THE BRITISH COLUMBIA REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2
BASIN 6 - PEACE-ATHABASCA RIVER IN THE BRITISH COLUMBIA REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN THE BRITISH COLUMBIA REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	60	60	60	60	60
1991	77	66	84	68	87
2001	97	68	117	77	121
2011	122	65	170	86	155

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN THE BRITISH COLUMBIA REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	61	61	61	61	61
1991	78	67	85	69	89
2001	98	69	118	78	123
2011	124	66	172	87	158

SUMMARY OF MANUFACTURING WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN THE BRITISH COLUMBIA REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	2	1	2	1	2
2011	2	1	3	1	2

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN THE BRITISH COLUMBIA REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN THE BRITISH COLUMBIA REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN THE BRITISH COLUMBIA REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN THE BRITISH COLUMBIA REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	6	6	6	6	6
1991	7	6	8	7	8
2001	8	6	11	7	10
2011	10	6	15	8	12

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN THE BRITISH COLUMBIA REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	6	6	6	6	6
1991	7	6	8	7	8
2001	8	6	11	7	10
2011	10	6	15	8	12

SUMMARY OF MUNICIPAL WATER CONSUMPTION BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN THE BRITISH COLUMBIA REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	1	1	2	1	1
2011	1	1	2	1	2

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
PRAIRIE REGION

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	2338	2338	2338	2338	2338
Mineral	197	197	197	197	197
Manufact	402	402	402	402	402
Power	1846	1846	1846	1846	1846
Municipal	579	579	579	579	579
Total	5363	5363	5363	5363	5363
1991					
Agricul	3038	2565	3011	2769	3291
Mineral	253	234	274	224	285
Manufact	553	476	649	507	603
Power	2407	2220	2808	2221	2601
Municipal	768	672	800	745	789
Total	7019	6167	7541	6465	7569
2001					
Agricul	3706	2483	3762	3126	4363
Mineral	339	283	408	287	393
Manufact	735	520	909	612	891
Power	3158	2636	4063	2800	3559
Municipal	894	658	1000	846	952
Total	8832	6580	10143	7671	10158
2011					
Agricul	4522	2148	4638	3480	5460
Mineral	456	337	656	348	498
Manufact	985	527	1294	711	1201
Power	4159	3067	5946	3304	4551
Municipal	1049	609	1331	943	1185
Total	11172	6687	13865	8786	12895

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011, PRAIRIE REGION

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	2338	2338	2338	2338	2338
Mineral	1683	1683	1683	1683	1683
Manufact	1723	1723	1723	1723	1723
Power	3714	3714	3714	3714	3714
Municipal	579	579	579	579	579
Total	10038	10038	10038	10038	10038
1991					
Agricul	3038	2565	3011	2769	3291
Mineral	2138	1971	2519	1884	2414
Manufact	2383	2058	2659	2149	2636
Power	4842	4466	5649	4468	5233
Municipal	768	672	800	745	789
Total	13168	11731	14638	12014	14363
2001					
Agricul	3706	2483	3762	3126	4363
Mineral	2852	2381	4021	2401	3324
Manufact	3280	2333	3860	2616	3970
Power	6353	5303	8174	5633	7160
Municipal	894	658	1000	846	952
Total	17084	13157	20817	14621	19769
2011					
Agricul	4522	2148	4638	3480	5460
Mineral	3819	2817	7027	2899	4205
Manufact	4558	2461	5691	3062	5429
Power	8363	6171	11962	6647	9156
Municipal	1049	609	1331	943	1185
Total	22312	14206	30649	17032	25435

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR, 1981-2011
PRAIRIE REGION

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	1892	1892	1892	1892	1892
Mineral	134	134	134	134	134
Manufact	73	73	73	73	73
Power	69	69	69	69	69
Municipal	87	87	87	87	87
Total	2256	2256	2256	2256	2256
1991					
Agricul	2459	2075	2437	2241	2663
Mineral	171	158	181	151	193
Manufact	102	89	119	92	114
Power	86	79	100	79	93
Municipal	105	92	109	102	109
Total	2924	2494	2947	2665	3172
2001					
Agricul	3000	2010	3045	2530	3531
Mineral	228	190	257	192	263
Manufact	138	101	173	109	174
Power	113	94	145	100	127
Municipal	123	90	136	115	132
Total	3600	2485	3756	3046	4227
2011					
Agricul	3660	1738	3754	2817	4419
Mineral	304	224	384	231	330
Manufact	187	108	254	125	241
Power	149	110	213	118	163
Municipal	144	83	180	128	166
Total	4443	2262	4784	3418	5318

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2338	2338	2338	2338	2338
1991	3038	2565	3011	2769	3291
2001	3706	2483	3762	3126	4363
2011	4522	2148	4638	3480	5460

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2338	2338	2338	2338	2338
1991	3038	2565	3011	2769	3291
2001	3706	2483	3762	3126	4363
2011	4522	2148	4638	3480	5460

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1892	1892	1892	1892	1892
1991	2459	2075	2437	2241	2663
2001	3000	2010	3045	2530	3531
2011	3660	1738	3754	2817	4419

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	197	197	197	197	197
1991	253	234	274	224	285
2001	339	283	408	287	393
2011	456	337	656	348	498

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1683	1683	1683	1683	1683
1991	2138	1971	2519	1884	2414
2001	2852	2381	4021	2401	3324
2011	3819	2817	7027	2899	4205

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	134	134	134	134	134
1991	171	158	181	151	193
2001	228	190	257	192	263
2011	304	224	384	231	330

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	402	402	402	402	402
1991	553	476	649	507	603
2001	735	520	909	612	891
2011	985	527	1294	711	1201

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1723	1723	1723	1723	1723
1991	2383	2058	2659	2149	2636
2001	3280	2333	3860	2616	3970
2011	4558	2461	5691	3062	5429

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	73	73	73	73	73
1991	102	89	119	92	114
2001	138	101	173	109	174
2011	187	108	254	125	241

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1946	1946	1946	1946	1946
1991	2407	2220	2808	2221	2601
2001	3158	2636	4063	2800	3559
2011	4159	3067	5946	3304	4551

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3814	3814	3814	3814	3814
1991	4842	4466	5649	4468	5233
2001	6353	5303	8174	5633	7160
2011	8363	6171	11962	6647	9156

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	69	69	69	69	69
1991	86	79	100	79	93
2001	113	94	145	100	127
2011	149	110	213	118	163

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	579	579	579	579	579
1991	768	672	800	745	789
2001	894	645	1000	846	952
2011	1049	609	1331	943	1185

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	579	579	579	579	579
1991	768	672	800	745	789
2001	894	658	1000	846	952
2011	1049	609	1331	943	1185

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	87	87	87	87	87
1991	105	92	109	102	109
2001	123	90	136	115	132
2011	144	83	180	128	166

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN PRAIRIE REGION

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	17	17	17	17	17
Mineral	84	84	84	84	84
Manufact	72	72	72	72	72
Power	4	4	4	4	4
Municipal	4	4	4	4	4
Total	180	180	180	180	180
1991					
Agricul	22	19	22	20	24
Mineral	107	99	108	95	121
Manufact	94	79	128	93	94
Power	5	4	6	4	5
Municipal	5	4	5	5	5
Total	233	206	268	217	249
2001					
Agricul	27	18	27	23	31
Mineral	143	119	145	121	164
Manufact	116	78	164	108	125
Power	6	5	8	6	7
Municipal	5	4	6	5	6
Total	297	224	351	262	334
2011					
Agricul	33	16	33	25	39
Mineral	190	140	195	144	205
Manufact	144	68	214	122	157
Power	8	6	12	7	9
Municipal	6	4	8	6	7
Total	381	234	462	304	418

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 6 - PEACE-ATHABASCA RIVER IN PRAIRIE REGION

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	17	17	17	17	17
Mineral	745	745	745	745	745
Manufact	108	108	108	108	108
Power	8	8	8	8	8
Municipal	4	4	4	4	4
Total	881	881	881	881	881
1991					
Agricul	22	19	22	20	24
Mineral	957	883	965	845	1078
Manufact	140	118	190	139	141
Power	10	9	11	9	11
Municipal	5	4	5	5	5
Total	1134	1033	1194	1017	1258
2001					
Agricul	27	18	27	23	31
Mineral	1272	1062	1292	1074	1463
Manufact	173	116	245	161	186
Power	13	11	16	11	14
Municipal	5	4	6	5	6
Total	1490	1210	1587	1275	1701
2011					
Agricul	33	16	33	25	39
Mineral	1696	1251	1740	1286	1829
Manufact	214	102	319	182	234
Power	17	12	24	13	18
Municipal	6	4	8	6	7
Total	1966	1384	2125	1512	2128

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN PRAIRIE REGION

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	17	17	17	17	17
Mineral	120	120	120	120	120
Manufact	13	13	13	13	13
Power	2	2	2	2	2
Municipal	1	1	1	1	1
Total	153	153	153	153	153
1991					
Agricul	22	18	22	20	24
Mineral	155	143	156	137	174
Manufact	17	15	24	17	17
Power	3	3	3	3	3
Municipal	1	1	1	1	1
Total	198	179	205	177	219
2001					
Agricul	27	18	27	23	31
Mineral	206	172	209	174	236
Manufact	21	14	31	20	23
Power	4	3	5	3	4
Municipal	1	1	1	1	1
Total	258	208	272	220	296
2011					
Agricul	33	15	33	25	39
Mineral	274	202	281	208	296
Manufact	27	13	40	23	29
Power	5	4	7	4	5
Municipal	1	1	1	1	1
Total	339	234	363	260	370

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	17	17	17	17	17
1991	22	19	22	20	24
2001	27	18	27	23	31
2011	33	16	33	25	39

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	17	17	17	17	17
1991	22	19	22	20	24
2001	27	18	27	23	31
2011	33	16	33	25	39

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	17	17	17	17	17
1991	22	18	22	20	24
2001	27	18	27	23	31
2011	33	15	33	25	39

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	84	84	84	84	84
1991	107	99	108	95	121
2001	143	119	145	121	164
2011	190	140	195	144	205

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	745	745	745	745	745
1991	957	883	965	845	1078
2001	1272	1062	1292	1074	1463
2011	1696	1251	1740	1286	1829

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN PRAIRIE REGION

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	120	120	120	120	120
1991	155	143	156	137	174
2001	206	172	209	174	236
2011	274	202	281	208	296

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	72	72	72	72	72
1991	94	79	128	93	94
2001	116	78	164	108	125
2011	144	68	214	122	157

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	108	108	108	108	108
1991	140	118	190	139	141
2001	173	116	245	161	186
2011	214	102	319	182	234

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	13	13	13	13	13
1991	17	15	24	17	17
2001	21	14	31	20	23
2011	27	13	40	23	29

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4	4	4	4	4
1991	5	4	6	4	5
2001	6	5	8	6	7
2011	8	6	12	7	9

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	8	8	8	8	8
1991	10	9	11	9	11
2001	13	11	16	11	14
2011	17	12	24	13	18

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2	2	2	2	2
1991	3	3	3	3	3
2001	4	3	5	3	4
2011	5	4	7	4	5

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4	4	4	4	4
1991	5	4	5	5	5
2001	5	4	6	5	6
2011	6	4	8	6	7

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4	4	4	4	4
1991	5	4	5	5	5
2001	5	4	6	5	6
2011	6	4	8	6	7

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 6 - PEACE-ATHABASCA RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	1	1	1	1	1
2011	1	1	1	1	1

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 7 - MACKENZIE RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	24	24	24	24	24
Manufact	1	1	1	1	1
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	25	25	25	25	25
1991					
Agricul	0	0	0	0	0
Mineral	32	29	29	29	35
Manufact	1	1	1	1	1
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	33	31	30	30	37
2001					
Agricul	0	0	0	0	0
Mineral	44	37	38	38	50
Manufact	2	1	2	1	2
Power	0	0	0	0	0
Municipal	0	0	0	0	[illegible]
Total	46	38	40	39	53
2011					
Agricul	0	0	0	0	0
Mineral	60	44	53	47	65
Manufact	3	1	3	1	2
Power	0	0	0	0	0
Municipal	0	0	1	0	0
Total	63	46	56	49	68

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 7 - MACKENZIE RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	36	36	36	36	36
Manufact	1	1	1	1	1
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	37	37	37	37	37
1991					
Agricul	0	0	0	0	0
Mineral	47	44	43	42	53
Manufact	1	1	1	1	1
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	49	45	45	44	54
2001					
Agricul	0	0	0	0	0
Mineral	65	54	58	56	75
Manufact	2	1	2	1	2
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	67	56	61	58	77
2011					
Agricul	0	0	0	0	0
Mineral	89	66	83	69	97
Manufact	3	1	3	1	2
Power	0	0	0	0	0
Municipal	0	0	1	0	0
Total	92	67	86	71	100

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 7 - MACKENZIE RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	2	2	2	2	2
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	2	2	2	2	2
1991					
Agricul	0	0	0	0	0
Mineral	3	2	2	2	3
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	3	3	3	3	3
2001					
Agricul	0	0	0	0	0
Mineral	3	3	3	3	4
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	4	3	3	3	4
2011					
Agricul	0	0	0	0	0
Mineral	5	4	4	4	5
Manufact	1	0	1	0	1
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	5	4	4	4	6

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 7 - MACKENZIE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 7 - MACKENZIE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 7 - MACKENZIE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-201
BASIN 7 - MACKENZIE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	24	24	24	24	24
1991	32	29	29	29	35
2001	44	37	38	38	50
2011	60	44	53	47	65

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2
BASIN 7 - MACKENZIE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	36	36	36	36	36
1991	47	44	43	42	53
2001	65	54	58	56	75
2011	89	66	83	69	97

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-20
BASIN 7 - MACKENZIE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2	2	2	2	2
1991	3	2	2	2	3
2001	3	3	3	3	4
2011	5	4	4	4	5

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 7 - MACKENZIE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	2	1	2	1	2
2011	3	1	3	1	2

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 7 - MACKENZIE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	2	1	2	1	2
2011	3	1	3	1	2

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 7 - MACKENZIE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	1	0	1	0	1

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 7 - MACKENZIE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 7 - MACKENZIE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 7 - MACKENZIE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 7 - MACKENZIE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	1	0	0

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 7 - MACKENZIE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	1	0	0

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 7 - MACKENZIE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 9 - MILK RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	46	46	46	46	46
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	110	110	110	110	110
Municipal	0	0	0	0	0
Total	156	156	156	156	156
1991					
Agricul	60	51	60	55	65
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	136	125	158	125	146
Municipal	0	0	0	0	0
Total	196	176	218	180	212
2001					
Agricul	74	49	75	62	87
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	178	148	229	158	200
Municipal	0	0	0	0	0
Total	251	198	304	220	287
2011					
Agricul	90	43	92	69	108
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	234	173	335	186	256
Municipal	0	0	0	0	0
Total	324	215	427	255	365

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011, BASIN 9 - MILK RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	46	46	46	46	46
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	215	215	215	215	215
Municipal	0	0	0	0	0
Total	261	261	261	261	261
1991					
Agricul	60	51	60	55	65
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	273	252	318	252	295
Municipal	0	0	0	0	0
Total	333	302	378	307	360
2001					
Agricul	74	49	75	62	87
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	358	299	460	317	403
Municipal	0	0	0	0	0
Total	431	348	535	379	490
2011					
Agricul	90	43	92	69	108
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	471	348	674	374	516
Municipal	0	0	0	0	0
Total	561	390	766	443	624

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 9 - MILK RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	38	38	38	38	38
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	1	1	1	1	1
Municipal	0	0	0	0	0
Total	38	38	38	38	38
1991					
Agricul	49	41	48	44	53
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	1	1	1	1	1
Municipal	0	0	0	0	0
Total	50	42	49	45	54
2001					
Agricul	59	40	60	50	70
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	1	1	2	1	1
Municipal	0	0	0	[illegible]	0
Total	61	41	62	51	71
2011					
Agricul	73	34	74	56	88
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	2	1	2	1	2
Municipal	0	0	0	0	0
Total	74	36	77	57	89

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 9 - MILK RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	46	46	46	46	46
1991	60	51	60	55	65
2001	74	49	75	62	87
2011	90	43	92	69	108

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 9 - MILK RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	46	46	46	46	46
1991	60	51	60	55	65
2001	74	49	75	62	87
2011	90	43	92	69	108

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 9 - MILK RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	38	38	38	38	38
1991	49	41	48	44	53
2001	59	40	60	50	70
2011	73	34	74	56	88

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-201

BASIN 9 - MILK RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2
BASIN 9 - MILK RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2
BASIN 9 - MILK RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 9 - MILK RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 9 - MILK RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 9 - MILK RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 9 - MILK RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	110	110	110	110	110
1991	136	125	158	125	146
2001	178	148	229	158	200
2011	234	173	335	186	256

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 9 - MILK RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	215	215	215	215	215
1991	273	252	318	252	295
2001	358	299	460	317	403
2011	471	348	674	374	516

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 9 - MILK RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	1	1	2	1	1
2011	2	1	2	1	2

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 9 - MILK RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 9 - MILK RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 9 - MILK RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 10 - NORTH SASKATCHEWAN RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	94	94	94	94	94
Mineral	55	55	55	55	55
Manufact	90	90	90	90	90
Power	1018	1018	1018	1018	1018
Municipal	132	132	132	132	132
Total	1388	1388	1388	1388	1388
1991					
Agricul	122	103	121	111	132
Mineral	70	65	80	62	79
Manufact	123	106	148	113	133
Power	1259	1161	1469	1162	1360
Municipal	177	154	184	172	181
Total	1751	1589	2002	1620	1886
2001					
Agricul	149	100	151	126	176
Mineral	94	78	123	79	109
Manufact	162	115	207	134	194
Power	1652	1379	2125	1464	1861
Municipal	206	151	231	196	218
Total	2262	1824	2838	1999	2558
2011					
Agricul	182	86	187	140	220
Mineral	125	92	206	95	137
Manufact	217	118	294	153	262
Power	2175	1604	3110	1728	2380
Municipal	242	140	310	219	268
Total	2941	2041	4106	2335	3267

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 10 - NORTH SASKATCHEWAN RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	94	94	94	94	94
Mineral	100	100	100	100	100
Manufact	744	744	744	744	744
Power	1995	1995	1995	1995	1995
Municipal	132	132	132	132	132
Total	3065	3065	3065	3065	3065
1991					
Agricul	122	103	121	111	132
Mineral	128	118	140	113	145
Manufact	1028	886	1126	931	1131
Power	2532	2336	2954	2337	2737
Municipal	177	154	184	172	181
Total	3987	3598	4526	3664	4326
2001					
Agricul	149	100	151	126	176
Mineral	171	142	206	144	198
Manufact	1434	1017	1647	1124	1686
Power	3323	2773	4275	2946	3745
Municipal	206	151	231	196	218
Total	5282	4184	6511	4535	6021
2011					
Agricul	182	86	187	140	220
Mineral	228	168	324	173	248
Manufact	2026	1087	2454	1309	2294
Power	4374	3227	6256	3476	4789
Municipal	242	140	310	219	268
Total	7051	4709	9530	5317	7819

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 10 - NORTH SASKATCHEWAN RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	76	76	76	76	76
Mineral	6	6	6	6	6
Manufact	27	27	27	27	27
Power	25	25	25	25	25
Municipal	20	20	20	20	20
Total	154	154	154	154	154
1991					
Agricul	99	83	98	90	107
Mineral	8	7	13	7	9
Manufact	37	33	42	33	42
Power	32	29	37	29	34
Municipal	24	21	25	23	25
Total	199	173	214	182	217
2001					
Agricul	121	81	122	102	142
Mineral	10	9	26	8	12
Manufact	52	38	62	39	66
Power	41	35	53	37	47
Municipal	28	20	31	26	30
Total	252	183	296	213	296
2011					
Agricul	147	70	151	113	178
Mineral	14	10	58	10	16
Manufact	73	42	95	45	92
Power	55	40	78	43	60
Municipal	33	19	41	29	37
Total	321	181	423	242	382

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 10 - NORTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	94	94	94	94	94
1991	122	103	121	111	132
2001	149	100	151	126	176
2011	182	86	187	140	220

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-20
BASIN 10 - NORTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	94	94	94	94	94
1991	122	103	121	111	132
2001	149	100	151	126	176
2011	182	86	187	140	220

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-20
BASIN 10 - NORTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	76	76	76	76	76
1991	99	83	98	90	107
2001	121	81	122	102	142
2011	147	70	151	113	178

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-
BASIN 10 - NORTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	55	55	55	55	55
1991	70	65	80	62	79
2001	94	78	123	79	109
2011	125	92	206	95	137

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 19
BASIN 10 - NORTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	100	100	100	100	100
1991	128	118	140	113	145
2001	171	142	206	144	198
2011	228	168	324	173	248

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 19
BASIN 10 - NORTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	6	6	6	6	6
1991	8	7	13	7	9
2001	10	9	26	8	12
2011	14	10	58	10	16

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 10 - NORTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	90	90	90	90	90
1991	123	106	148	113	133
2001	162	115	207	134	194
2011	217	118	294	153	262

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 10 - NORTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	744	744	744	744	744
1991	1028	886	1126	931	1131
2001	1434	1017	1647	1124	1686
2011	2026	1087	2454	1309	2294

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 10 - NORTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	27	27	27	27	27
1991	37	33	42	33	42
2001	52	38	62	39	66
2011	73	42	95	45	92

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 10 - NORTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1018	1018	1018	1018	1018
1991	1259	1161	1469	1162	1360
2001	1652	1379	2125	1464	1861
2011	2175	1604	3110	1728	2380

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 10 - NORTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1995	1995	1995	1995	1995
1991	2532	2336	2954	2337	2737
2001	3323	2773	4275	2946	3745
2011	4374	3227	6256	3476	4789

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 10 - NORTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	25	25	25	25	25
1991	32	29	37	29	34
2001	41	35	53	37	47
2011	55	40	78	43	60

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 10 - NORTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	132	132	132	132	132
1991	177	154	184	172	181
2001	206	149	231	196	218
2011	242	140	310	219	268

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 10 - NORTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	132	132	132	132	132
1991	177	154	184	172	181
2001	206	151	231	196	218
2011	242	140	310	219	268

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 10 - NORTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	20	20	20	20	20
1991	24	21	25	23	25
2001	28	20	31	26	30
2011	33	19	41	29	37

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 11A - RED DEER RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	428	428	428	428	428
Mineral	3	3	3	3	3
Manufact	5	5	5	5	5
Power	0	0	0	0	0
Municipal	22	22	22	22	22
Total	459	459	459	459	459
1991					
Agricul	557	470	552	507	603
Mineral	3	3	3	3	4
Manufact	7	7	9	6	9
Power	0	0	0	0	0
Municipal	29	26	30	28	30
Total	597	505	594	545	646
2001					
Agricul	679	455	690	573	800
Mineral	4	4	5	4	5
Manufact	10	8	13	7	14
Power	0	0	0	0	0
Municipal	34	25	38	32	37
Total	728	491	745	616	855
2011					
Agricul	829	394	850	638	1001
Mineral	6	4	6	5	6
Manufact	14	9	19	9	19
Power	0	0	0	0	0
Municipal	40	23	50	36	46
Total	888	430	925	686	1073

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011, BASIN 11A - RED DEER RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	428	428	428	428	428
Mineral	330	330	330	330	330
Manufact	8	8	8	8	8
Power	0	0	0	0	0
Municipal	22	22	22	22	22
Total	789	789	789	789	789
1991					
Agricul	557	470	552	507	603
Mineral	424	391	428	374	478
Manufact	11	10	13	10	13
Power	0	0	0	0	0
Municipal	29	26	30	28	30
Total	1022	897	1023	920	1124
2001					
Agricul	679	455	690	573	800
Mineral	563	470	572	476	648
Manufact	16	12	20	12	21
Power	0	0	0	0	0
Municipal	34	25	38	32	37
Total	1292	963	1320	1092	1506
2011					
Agricul	829	394	850	638	1001
Mineral	752	554	771	570	811
Manufact	21	13	31	13	31
Power	0	0	0	0	0
Municipal	40	23	50	36	46
Total	1641	984	1702	1256	1888

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 11A - RED DEER RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	346	346	346	346	346
Mineral	7	7	7	7	7
Manufact	4	4	4	4	4
Power	0	0	0	0	0
Municipal	3	3	3	3	3
Total	360	360	360	360	360
1991					
Agricul	450	380	446	410	487
Mineral	8	8	9	7	10
Manufact	6	5	7	5	7
Power	0	0	0	0	0
Municipal	4	4	4	4	4
Total	468	396	465	426	508
2001					
Agricul	549	368	557	463	646
Mineral	11	9	11	10	13
Manufact	8	6	10	6	11
Power	0	0	0	0	0
Municipal	5	4	5	4	5
Total	573	387	584	483	675
2011					
Agricul	670	318	687	515	808
Mineral	15	11	15	11	16
Manufact	11	7	16	7	16
Power	0	0	0	0	0
Municipal	6	3	7	5	7
Total	701	339	725	538	847

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 11A - RED DEER RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	428	428	428	428	428
1991	557	470	552	507	603
2001	679	455	690	573	800
2011	829	394	850	638	1001

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11A - RED DEER RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	428	428	428	428	428
1991	557	470	552	507	603
2001	679	455	690	573	800
2011	829	394	850	638	1001

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11A - RED DEER RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	346	346	346	346	346
1991	450	380	446	410	487
2001	549	368	557	463	646
2011	670	318	687	515	808

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2
BASIN 11A - RED DEER RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3	3	3	3	3
1991	3	3	3	3	4
2001	4	4	5	4	5
2011	6	4	6	5	6

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 198
BASIN 11A - RED DEER RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	330	330	330	330	330
1991	424	391	428	374	478
2001	563	470	572	476	648
2011	752	554	771	570	811

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 198
BASIN 11A - RED DEER RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	7	7	7	7	7
1991	8	8	9	7	10
2001	11	9	11	10	13
2011	15	11	15	11	16

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 11A - RED DEER RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	5	5	5	5	5
1991	7	7	9	6	9
2001	10	8	13	7	14
2011	14	9	19	9	19

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11A - RED DEER RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	8	8	8	8	8
1991	11	10	13	10	13
2001	16	12	20	12	21
2011	21	13	31	13	31

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11A - RED DEER RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4	4	4	4	4
1991	6	5	7	5	7
2001	8	6	10	6	11
2011	11	7	16	7	16

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 11A - RED DEER RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11A - RED DEER RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11A - RED DEER RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 11A - RED DEER RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	22	22	22	22	22
1991	29	26	30	28	30
2001	34	24	38	32	37
2011	40	23	50	36	46

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11A - RED DEER RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	22	22	22	22	22
1991	29	26	30	28	30
2001	34	25	38	32	37
2011	40	23	50	36	46

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11A - RED DEER RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3	3	3	3	3
1991	4	4	4	4	4
2001	5	4	5	4	5
2011	6	3	7	5	7

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 11B - BOW RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	559	559	559	559	559
Mineral	1	1	1	1	1
Manufact	85	85	85	85	85
Power	0	0	0	0	0
Municipal	168	168	168	168	168
Total	813	813	813	813	813
1991					
Agricul	726	613	719	662	786
Mineral	2	2	2	1	2
Manufact	121	107	140	105	139
Power	0	0	0	0	0
Municipal	219	192	227	211	226
Total	1068	913	1088	980	1153
2001					
Agricul	885	593	899	747	1043
Mineral	2	2	2	2	3
Manufact	164	125	208	124	221
Power	0	0	0	0	0
Municipal	255	187	282	239	274
Total	1307	907	1392	1112	1539
2011					
Agricul	1080	513	1108	832	1305
Mineral	3	2	3	2	3
Manufact	225	138	314	142	312
Power	0	0	0	0	0
Municipal	299	173	372	265	346
Total	1607	827	1798	1242	1966

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 11B - BOW RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	559	559	559	559	559
Mineral	18	18	18	18	18
Manufact	164	164	164	164	164
Power	0	0	0	0	0
Municipal	168	168	168	168	168
Total	910	910	910	910	910
1991					
Agricul	726	613	719	662	786
Mineral	24	22	24	21	27
Manufact	238	210	274	207	273
Power	0	0	0	0	0
Municipal	219	192	227	211	226
Total	1206	1037	1245	1100	1312
2001					
Agricul	885	593	899	747	1043
Mineral	31	26	32	27	36
Manufact	321	244	407	244	432
Power	0	0	0	0	0
Municipal	255	187	282	239	274
Total	1493	1051	1621	1256	1784
2011					
Agricul	1080	513	1108	832	1305
Mineral	42	31	43	32	45
Manufact	437	269	613	279	610
Power	0	0	0	0	0
Municipal	299	173	372	265	346
Total	1858	987	2136	1408	2306

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11B - BOW RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	451	451	451	451	451
Mineral	3	3	3	3	3
Manufact	4	4	4	4	4
Power	0	0	0	0	0
Municipal	25	25	25	25	25
Total	483	483	483	483	483
1991					
Agricul	587	495	581	535	635
Mineral	3	3	3	3	4
Manufact	6	5	7	5	7
Power	0	0	0	0	0
Municipal	31	27	32	29	32
Total	626	530	623	572	677
2001					
Agricul	715	479	726	603	842
Mineral	4	4	4	4	5
Manufact	8	6	10	6	10
Power	0	0	0	0	0
Municipal	36	26	39	33	39
Total	763	515	779	647	896
2011					
Agricul	873	415	896	672	1054
Mineral	6	4	6	4	6
Manufact	11	6	14	7	14
Power	0	0	0	0	0
Municipal	42	24	51	37	50
Total	931	449	967	720	1124

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 11B - BOW RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	559	559	559	559	559
1991	726	613	719	662	786
2001	885	593	899	747	1043
2011	1080	513	1108	832	1305

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11B - BOW RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	559	559	559	559	559
1991	726	613	719	662	786
2001	885	593	899	747	1043
2011	1080	513	1108	832	1305

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11B - BOW RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	451	451	451	451	451
1991	587	495	581	535	635
2001	715	479	726	603	842
2011	873	415	896	672	1054

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-20
BASIN 11B - BOW RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	2	2	2	1	2
2001	2	2	2	2	3
2011	3	2	3	2	3

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-
BASIN 11B - BOW RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	18	18	18	18	18
1991	24	22	24	21	27
2001	31	26	32	27	36
2011	42	31	43	32	45

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-
BASIN 11B - BOW RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3	3	3	3	3
1991	3	3	3	3	4
2001	4	4	4	4	5
2011	6	4	6	4	6

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 11B - BOW RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	85	85	85	85	85
1991	121	107	140	105	139
2001	164	125	208	124	221
2011	225	138	314	142	312

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11B - BOW RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	164	164	164	164	164
1991	238	210	274	207	273
2001	321	244	407	244	432
2011	437	269	613	279	610

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11B - BOW RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4	4	4	4	4
1991	6	5	7	5	7
2001	8	6	10	6	10
2011	11	6	14	7	14

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 11B - BOW RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-201
BASIN 11B - BOW RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-201
BASIN 11B - BOW RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 11B - BOW RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	168	168	168	168	168
1991	219	192	227	211	226
2001	255	183	282	239	274
2011	299	173	372	265	346

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11B - BOW RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	168	168	168	168	168
1991	219	192	227	211	226
2001	255	187	282	239	274
2011	299	173	372	265	346

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11B - BOW RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	25	25	25	25	25
1991	31	27	32	29	32
2001	36	26	39	33	39
2011	42	24	51	37	50

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 11C - OLDMAN RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	551	551	551	551	551
Mineral	0	0	0	0	0
Manufact	10	10	10	10	10
Power	0	0	0	0	0
Municipal	12	12	12	12	12
Total	573	573	573	573	573
1991					
Agricul	717	605	710	653	776
Mineral	0	0	0	0	0
Manufact	14	12	15	13	16
Power	0	0	0	0	0
Municipal	15	13	16	15	16
Total	746	631	742	681	808
2001					
Agricul	874	586	887	737	1029
Mineral	0	0	0	0	0
Manufact	18	13	21	15	22
Power	0	0	0	0	0
Municipal	18	13	20	17	19
Total	910	612	928	769	1070
2011					
Agricul	1066	507	1094	821	1288
Mineral	0	0	0	0	0
Manufact	23	13	28	17	28
Power	0	0	0	0	0
Municipal	21	12	26	19	24
Total	1110	532	1148	857	1340

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 11C - OLDMAN RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	551	551	551	551	551
Mineral	5	5	5	5	5
Manufact	11	11	11	11	11
Power	0	0	0	0	0
Municipal	12	12	12	12	12
Total	579	579	579	579	579
1991					
Agricul	717	605	710	653	776
Mineral	6	6	6	5	7
Manufact	16	14	18	15	18
Power	0	0	0	0	0
Municipal	15	13	16	15	16
Total	754	638	750	688	817
2001					
Agricul	874	586	887	737	1029
Mineral	8	7	8	7	9
Manufact	20	15	24	17	25
Power	0	0	0	0	0
Municipal	18	13	20	17	19
Total	920	621	939	778	1083
2011					
Agricul	1066	507	1094	821	1288
Mineral	11	8	11	8	12
Manufact	26	15	32	19	32
Power	0	0	0	0	0
Municipal	21	12	26	19	24
Total	1124	542	1163	867	1356

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 11C - OLDMAN RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	446	446	446	446	446
Mineral	0	0	0	0	0
Manufact	2	2	2	2	2
Power	0	0	0	0	0
Municipal	2	2	2	2	2
Total	450	450	450	450	450
1991					
Agricul	579	489	574	528	627
Mineral	0	0	0	0	0
Manufact	3	3	3	3	3
Power	0	0	0	0	0
Municipal	2	2	2	2	2
Total	584	493	580	533	633
2001					
Agricul	706	473	717	596	832
Mineral	0	0	0	0	0
Manufact	4	3	5	3	5
Power	0	0	0	0	0
Municipal	3	2	3	2	3
Total	713	478	725	601	840
2011					
Agricul	862	409	884	663	1041
Mineral	1	0	1	0	1
Manufact	5	3	7	3	7
Power	0	0	0	0	0
Municipal	3	2	4	3	3
Total	870	414	895	670	1051

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 11C - OLDMAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	551	551	551	551	551
1991	717	605	710	653	776
2001	874	586	887	737	1029
2011	1066	507	1094	821	1288

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11C - OLDMAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	551	551	551	551	551
1991	717	605	710	653	776
2001	874	586	887	737	1029
2011	1066	507	1094	821	1288

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11C - OLDMAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	446	446	446	446	446
1991	579	489	574	528	627
2001	706	473	717	596	832
2011	862	409	884	663	1041

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-201
BASIN 11C - OLDMAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-
BASIN 11C - OLDMAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	5	5	5	5	5
1991	6	6	6	5	7
2001	8	7	8	7	9
2011	11	8	11	8	12

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-
BASIN 11C - OLDMAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	1	0	1	0	1

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 11C - OLDMAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	10	10	10	10	10
1991	14	12	15	13	16
2001	18	13	21	15	22
2011	23	13	28	17	28

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11C - OLDMAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	11	11	11	11	11
1991	16	14	18	15	18
2001	20	15	24	17	25
2011	26	15	32	19	32

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11C - OLDMAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2	2	2	2	2
1991	3	3	3	3	3
2001	4	3	5	3	5
2011	5	3	7	3	7

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 11C - OLDMAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11C - OLDMAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11C - OLDMAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 11C - OLDMAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	12	12	12	12	12
1991	15	13	16	15	16
2001	18	13	20	17	19
2011	21	12	26	19	24

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11C - OLDMAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	12	12	12	12	12
1991	15	13	16	15	16
2001	18	13	20	17	19
2011	21	12	26	19	24

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11C - OLDMAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2	2	2	2	2
1991	2	2	2	2	2
2001	3	2	3	2	3
2011	3	2	4	3	3

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 11D - SOUTH SASKATCHEWAN RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	425	425	425	425	425
Mineral	4	4	4	4	4
Manufact	21	21	21	21	21
Power	202	202	202	202	202
Municipal	62	62	62	62	62
Total	713	713	713	713	713
1991					
Agricul	552	466	547	503	598
Mineral	5	4	8	4	5
Manufact	31	27	36	27	35
Power	249	230	291	230	270
Municipal	80	70	84	78	83
Total	917	798	965	841	991
2001					
Agricul	673	451	683	568	793
Mineral	6	5	16	5	8
Manufact	41	31	53	31	56
Power	327	273	421	290	369
Municipal	93	69	104	88	100
Total	1141	830	1276	982	1325
2011					
Agricul	821	390	843	632	992
Mineral	8	6	34	6	10
Manufact	56	35	79	36	79
Power	431	318	616	342	472
Municipal	110	64	137	97	127
Total	1426	812	1709	1114	1679

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 11D - SOUTH SASKATCHEWAN RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	425	425	425	425	425
Mineral	214	214	214	214	214
Manufact	195	195	195	195	195
Power	395	395	395	395	395
Municipal	62	62	62	62	62
Total	1290	1290	1290	1290	1290
1991					
Agricul	552	466	547	503	598
Mineral	261	241	440	229	298
Manufact	284	253	333	244	329
Power	502	463	585	463	542
Municipal	80	70	84	78	83
Total	1679	1492	1989	1516	1850
2001					
Agricul	673	451	683	568	793
Mineral	351	293	898	292	424
Manufact	386	297	502	287	533
Power	658	550	847	584	742
Municipal	93	69	104	88	100
Total	2162	1659	3034	1818	2593
2011					
Agricul	821	390	843	632	992
Mineral	474	349	1973	359	551
Manufact	528	333	765	328	765
Power	867	639	1240	689	949
Municipal	110	64	137	97	127
Total	2799	1776	4957	2106	3384

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 11D - SOUTH SASKATCHEWAN RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	343	343	343	343	343
Mineral	3	3	3	3	3
Manufact	15	15	15	15	15
Power	17	17	17	17	17
Municipal	9	9	9	9	9
Total	387	387	387	387	387
1991					
Agricul	446	376	442	406	483
Mineral	3	3	5	3	4
Manufact	22	19	26	19	25
Power	21	19	24	19	23
Municipal	11	10	12	11	12
Total	503	428	509	458	546
2001					
Agricul	544	364	552	459	640
Mineral	4	4	10	4	5
Manufact	30	23	39	22	41
Power	27	23	35	24	31
Municipal	13	10	14	12	14
Total	618	423	651	521	732
2011					
Agricul	664	315	681	511	801
Mineral	6	4	22	4	7
Manufact	41	26	59	25	59
Power	36	27	52	29	39
Municipal	15	9	19	13	18
Total	761	381	833	583	925

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 11D - SOUTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	425	425	425	425	425
1991	552	466	547	503	598
2001	673	451	683	568	793
2011	821	390	843	632	992

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11D - SOUTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	425	425	425	425	425
1991	552	466	547	503	598
2001	673	451	683	568	793
2011	821	390	843	632	992

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11D - SOUTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	343	343	343	343	343
1991	446	376	442	406	483
2001	544	364	552	459	640
2011	664	315	681	511	801

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2
BASIN 11D - SOUTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4	4	4	4	4
1991	5	4	8	4	5
2001	6	5	16	5	8
2011	8	6	34	6	10

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 198
BASIN 11D - SOUTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	214	214	214	214	214
1991	261	241	440	229	298
2001	351	293	898	292	424
2011	474	349	1973	359	551

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 198
BASIN 11D - SOUTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3	3	3	3	3
1991	3	3	5	3	4
2001	4	4	10	4	5
2011	6	4	22	4	7

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 11D - SOUTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	21	21	21	21	21
1991	31	27	36	27	35
2001	41	31	53	31	56
2011	56	35	79	36	79

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11D - SOUTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	195	195	195	195	195
1991	284	253	333	244	329
2001	386	297	502	287	533
2011	528	333	765	328	765

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11D - SOUTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	15	15	15	15	15
1991	22	19	26	19	25
2001	30	23	39	22	41
2011	41	26	59	25	59

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 11D - SOUTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	202	202	202	202	202
1991	249	230	291	230	270
2001	327	273	421	290	369
2011	431	318	616	342	472

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11D - SOUTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	395	395	395	395	395
1991	502	463	585	463	542
2001	658	550	847	584	742
2011	867	639	1240	689	949

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11D - SOUTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	17	17	17	17	17
1991	21	19	24	19	23
2001	27	23	35	24	31
2011	36	27	52	29	39

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 11D - SOUTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	62	62	62	62	62
1991	80	70	84	78	83
2001	93	67	104	88	100
2011	110	64	137	97	127

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11D - SOUTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	62	62	62	62	62
1991	80	70	84	78	83
2001	93	69	104	88	100
2011	110	64	137	97	127

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 11D - SOUTH SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	9	9	9	9	9
1991	11	10	12	11	12
2001	13	10	14	12	14
2011	15	9	19	13	18

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12A - OLD WIVES LAKE (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	64	64	64	64	64
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	64	64	64	64	64
1991					
Agricul	83	70	82	75	90
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	83	70	83	76	90
2001					
Agricul	101	68	102	85	119
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	102	68	103	86	120
2011					
Agricul	123	58	126	95	149
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	1	0	1	1	1
Total	124	59	127	95	150

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 12A - OLD WIVES LAKE (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	64	64	64	64	64
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	64	64	64	64	64
1991					
Agricul	83	70	82	75	90
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	83	70	83	76	90
2001					
Agricul	101	68	102	85	119
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	102	68	103	86	120
2011					
Agricul	123	58	126	95	149
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	1	0	1	1	1
Total	124	59	127	95	150

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 12A - OLD WIVES LAKE (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	51	51	51	51	51
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	51	51	51	51	51
1991					
Agricul	67	56	66	61	72
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	67	56	66	61	72
2001					
Agricul	81	55	83	69	96
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	82	55	83	69	96
2011					
Agricul	99	47	102	77	120
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	100	47	102	77	120

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12A - OLD WIVES LAKE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	64	64	64	64	64
1991	83	70	82	75	90
2001	101	68	102	85	119
2011	123	58	126	95	149

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12A - OLD WIVES LAKE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	64	64	64	64	64
1991	83	70	82	75	90
2001	101	68	102	85	119
2011	123	58	126	95	149

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12A - OLD WIVES LAKE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	51	51	51	51	51
1991	67	56	66	61	72
2001	81	55	83	69	96
2011	99	47	102	77	120

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-20
BASIN 12A - OLD WIVES LAKE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981
BASIN 12A - OLD WIVES LAKE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981
BASIN 12A - OLD WIVES LAKE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12A - OLD WIVES LAKE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12A - OLD WIVES LAKE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12A - OLD WIVES LAKE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12A - OLD WIVES LAKE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-201
BASIN 12A - OLD WIVES LAKE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12A - OLD WIVES LAKE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12A - OLD WIVES LAKE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	1	1	1	1	1
2001	1	1	1	1	1
2011	1	0	1	1	1

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12A - OLD WIVES LAKE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	1	1	1	1	1
2001	1	1	1	1	1
2011	1	0	1	1	1

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12A - OLD WIVES LAKE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12B - QU'APPELLE RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	50	50	50	50	50
Mineral	13	13	13	13	13
Manufact	3	3	3	3	3
Power	0	0	0	0	0
Municipal	31	31	31	31	31
Total	97	97	97	97	97
1991					
Agricul	65	55	65	59	71
Mineral	16	15	28	14	19
Manufact	4	4	4	4	5
Power	0	0	0	0	0
Municipal	41	36	43	40	42
Total	127	110	140	118	136
2001					
Agricul	80	53	81	67	94
Mineral	22	19	58	18	27
Manufact	6	4	6	5	6
Power	0	0	0	0	0
Municipal	48	35	54	46	51
Total	155	111	198	136	178
2011					
Agricul	97	46	100	75	117
Mineral	30	22	127	23	35
Manufact	8	4	9	5	8
Power	0	0	0	0	0
Municipal	56	33	72	51	62
Total	191	105	307	154	223

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 12B - QU'APPELLE RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	50	50	50	50	50
Mineral	217	217	217	217	217
Manufact	148	148	148	148	148
Power	0	0	0	0	0
Municipal	31	31	31	31	31
Total	445	445	445	445	445
1991					
Agricul	65	55	65	59	71
Mineral	265	244	451	232	302
Manufact	209	175	213	191	228
Power	0	0	0	0	0
Municipal	41	36	43	40	42
Total	581	510	771	522	643
2001					
Agricul	80	53	81	67	94
Mineral	356	297	924	296	431
Manufact	297	193	306	251	333
Power	0	0	0	0	0
Municipal	48	35	54	46	51
Total	780	579	1365	660	908
2011					
Agricul	97	46	100	75	117
Mineral	480	354	2036	365	560
Manufact	423	187	445	310	441
Power	0	0	0	0	0
Municipal	56	33	72	51	62
Total	1057	621	2653	800	1180

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 12B - QU'APPELLE RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	41	41	41	41	41
Mineral	3	3	3	3	3
Manufact	1	1	1	1	1
Power	0	0	0	0	0
Municipal	5	5	5	5	5
Total	49	49	49	49	49
1991					
Agricul	53	44	52	48	57
Mineral	3	3	6	3	4
Manufact	1	1	1	1	2
Power	0	0	0	0	0
Municipal	6	5	6	5	6
Total	63	54	65	58	68
2001					
Agricul	64	43	65	54	76
Mineral	5	4	12	4	6
Manufact	2	1	2	2	2
Power	0	0	0	0	0
Municipal	6	5	7	6	7
Total	78	53	87	66	91
2011					
Agricul	78	37	80	60	95
Mineral	6	5	27	5	7
Manufact	3	2	3	2	3
Power	0	0	0	0	0
Municipal	8	4	10	7	9
Total	95	48	120	74	114

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12B - QU'APPELLE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	50	50	50	50	50
1991	65	55	65	59	71
2001	80	53	81	67	94
2011	97	46	100	75	117

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12B - QU'APPELLE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	50	50	50	50	50
1991	65	55	65	59	71
2001	80	53	81	67	94
2011	97	46	100	75	117

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12B - QU'APPELLE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	41	41	41	41	41
1991	53	44	52	48	57
2001	64	43	65	54	76
2011	78	37	80	60	95

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-201
BASIN 12B - QU'APPELLE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	13	13	13	13	13
1991	16	15	28	14	19
2001	22	19	58	18	27
2011	30	22	127	23	35

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2
BASIN 12B - QU'APPELLE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	217	217	217	217	217
1991	265	244	451	232	302
2001	356	297	924	296	431
2011	480	354	2036	365	560

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2
BASIN 12B - QU'APPELLE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3	3	3	3	3
1991	3	3	6	3	4
2001	5	4	12	4	6
2011	6	5	27	5	7

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12B - QU'APPELLE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3	3	3	3	3
1991	4	4	4	4	5
2001	6	4	6	5	6
2011	8	4	9	5	8

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12B - QU'APPELLE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	148	148	148	148	148
1991	209	175	213	191	228
2001	297	193	306	251	333
2011	423	187	445	310	441

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12B - QU'APPELLE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	2
2001	2	1	2	2	2
2011	3	2	3	2	3

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12B - QU'APPELLE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12B - QU'APPELLE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12B - QU'APPELLE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12B - QU'APPELLE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	31	31	31	31	31
1991	41	36	43	40	42
2001	48	35	54	46	51
2011	56	33	72	51	62

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12B - QU'APPELLE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	31	31	31	31	31
1991	41	36	43	40	42
2001	48	35	54	46	51
2011	56	33	72	51	62

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12B - QU'APPELLE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	5	5	5	5	5
1991	6	5	6	5	6
2001	6	5	7	6	7
2011	8	4	10	7	9

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12C - SOURIS RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	25	25	25	25	25
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	554	554	554	554	554
Municipal	4	4	4	4	4
Total	583	583	583	583	583
1991					
Agricul	32	27	32	29	35
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	685	632	799	632	740
Municipal	5	5	5	5	5
Total	723	664	837	667	781
2001					
Agricul	39	26	40	33	46
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	899	750	1157	797	1013
Municipal	6	4	7	6	6
Total	945	782	1204	837	1067
2011					
Agricul	48	23	49	37	58
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	1184	873	1693	941	1296
Municipal	7	4	9	6	8
Total	1240	900	1752	985	1362

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011, BASIN 12C - SOURIS RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	25	25	25	25	25
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	1086	1086	1086	1086	1086
Municipal	4	4	4	4	4
Total	1115	1115	1115	1115	1115
1991					
Agricul	32	27	32	29	35
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	1378	1271	1608	1272	1490
Municipal	5	5	5	5	5
Total	1417	1304	1646	1307	1531
2001					
Agricul	39	26	40	33	46
Mineral	0	0	0	0	0
Manufact	1	0	1	0	1
Power	1809	1510	2327	1604	2038
Municipal	6	4	7	6	6
Total	1855	1541	2375	1643	2092
2011					
Agricul	48	23	49	37	58
Mineral	0	0	0	0	0
Manufact	1	0	1	1	1
Power	2381	1757	3405	1892	2607
Municipal	7	4	9	6	8
Total	2437	1784	3465	1937	2674

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12C - SOURIS RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	20	20	20	20	20
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	24	24	24	24	24
Municipal	1	1	1	1	1
Total	45	45	45	45	45
1991					
Agricul	26	22	26	24	28
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	30	27	35	27	32
Municipal	1	1	1	1	1
Total	57	50	61	52	61
2001					
Agricul	32	21	32	27	38
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	39	33	50	35	44
Municipal	1	1	1	1	1
Total	72	55	83	62	82
2011					
Agricul	39	18	40	30	47
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	51	38	73	41	56
Municipal	1	1	1	1	1
Total	91	57	115	72	104

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12C - SOURIS RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	25	25	25	25	25
1991	32	27	32	29	35
2001	39	26	40	33	46
2011	48	23	49	37	58

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12C - SOURIS RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	25	25	25	25	25
1991	32	27	32	29	35
2001	39	26	40	33	46
2011	48	23	49	37	58

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12C - SOURIS RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	20	20	20	20	20
1991	26	22	26	24	28
2001	32	21	32	27	38
2011	39	18	40	30	47

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-20

BASIN 12C - SOURIS RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-
BASIN 12C - SOURIS RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-
BASIN 12C - SOURIS RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12C - SOURIS RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	1

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12C - SOURIS RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	1	0	1	0	1
2011	1	0	1	1	1

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12C - SOURIS RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12C - SOURIS RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	554	554	554	554	554
1991	685	632	799	632	740
2001	899	750	1157	797	1013
2011	1184	873	1693	941	1296

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12C - SOURIS RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1086	1086	1086	1086	1086
1991	1378	1271	1608	1272	1490
2001	1809	1510	2327	1604	2038
2011	2381	1757	3405	1892	2607

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12C - SOURIS RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	24	24	24	24	24
1991	30	27	35	27	32
2001	39	33	50	35	44
2011	51	38	73	41	56

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12C - SOURIS RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4	4	4	4	4
1991	5	5	5	5	5
2001	6	4	7	6	6
2011	7	4	9	6	8

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12C - SOURIS RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4	4	4	4	4
1991	5	5	5	5	5
2001	6	4	7	6	6
2011	7	4	9	6	8

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12C - SOURIS RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	1	1	1	1	1
2011	1	1	1	1	1

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12D - ASSINIBOINE RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	32	32	32	32	32
Mineral	1	1	1	1	1
Manufact	4	4	4	4	4
Power	56	56	56	56	56
Municipal	17	17	17	17	17
Total	110	110	110	110	110
1991					
Agricul	42	36	42	38	46
Mineral	1	1	1	1	1
Manufact	5	5	6	5	6
Power	70	64	81	64	75
Municipal	22	19	23	22	23
Total	140	125	154	130	151
2001					
Agricul	51	34	52	43	61
Mineral	1	1	3	1	1
Manufact	7	5	8	6	9
Power	91	76	118	81	103
Municipal	26	19	29	25	27
Total	177	136	210	156	201
2011					
Agricul	63	30	64	48	76
Mineral	2	1	7	1	2
Manufact	9	6	12	6	12
Power	120	89	172	96	132
Municipal	30	18	39	28	34
Total	224	143	294	179	255

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011, BASIN 12D - ASSINIBOINE RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	32	32	32	32	32
Mineral	1	1	1	1	1
Manufact	65	65	65	65	65
Power	110	110	110	110	110
Municipal	17	17	17	17	17
Total	226	226	226	226	226
1991					
Agricul	42	36	42	38	46
Mineral	2	2	3	1	2
Manufact	94	84	111	81	110
Power	140	129	164	129	151
Municipal	22	19	23	22	23
Total	301	270	342	272	331
2001					
Agricul	51	34	52	43	61
Mineral	2	2	6	2	3
Manufact	129	99	167	96	178
Power	184	154	237	163	207
Municipal	26	19	29	25	27
Total	392	308	491	329	475
2011					
Agricul	63	30	64	48	76
Mineral	3	2	13	2	4
Manufact	176	111	255	109	255
Power	242	179	346	192	265
Municipal	30	18	39	28	34
Total	514	339	717	380	633

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 12D - ASSINIBOINE RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	26	26	26	26	26
Mineral	0	0	0	0	0
Manufact	2	2	2	2	2
Power	0	0	0	0	0
Municipal	2	2	2	2	2
Total	30	30	30	30	30
1991					
Agricul	34	29	34	31	37
Mineral	0	0	0	0	0
Manufact	2	2	3	2	3
Power	0	0	0	0	0
Municipal	3	3	3	3	3
Total	39	33	40	36	43
2001					
Agricul	42	28	42	35	49
Mineral	0	0	0	0	0
Manufact	3	2	4	2	4
Power	0	0	0	0	0
Municipal	3	3	4	3	4
Total	48	33	50	41	57
2011					
Agricul	51	24	52	39	61
Mineral	0	0	0	0	0
Manufact	4	3	6	3	6
Power	0	0	0	0	0
Municipal	4	2	5	4	5
Total	59	29	63	45	72

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12D - ASSINIBOINE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	32	32	32	32	32
1991	42	36	42	38	46
2001	51	34	52	43	61
2011	63	30	64	48	76

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12D - ASSINIBOINE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	32	32	32	32	32
1991	42	36	42	38	46
2001	51	34	52	43	61
2011	63	30	64	48	76

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12D - ASSINIBOINE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	26	26	26	26	26
1991	34	29	34	31	37
2001	42	28	42	35	49
2011	51	24	52	39	61

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-20
BASIN 12D - ASSINIBOINE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	1	1	3	1	1
2011	2	1	7	1	2

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-
BASIN 12D - ASSINIBOINE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	2	2	3	1	2
2001	2	2	6	2	3
2011	3	2	13	2	4

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-
BASIN 12D - ASSINIBOINE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12D - ASSINIBOINE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4	4	4	4	4
1991	5	5	6	5	6
2001	7	5	8	6	9
2011	9	6	12	6	12

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12D - ASSINIBOINE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	65	65	65	65	65
1991	94	84	111	81	110
2001	129	99	167	96	178
2011	176	111	255	109	255

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12D - ASSINIBOINE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2	2	2	2	2
1991	2	2	3	2	3
2001	3	2	4	2	4
2011	4	3	6	3	6

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12D - ASSINIBOINE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	56	56	56	56	56
1991	70	64	81	64	75
2001	91	76	118	81	103
2011	120	89	172	96	132

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12D - ASSINIBOINE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	110	110	110	110	110
1991	140	129	164	129	151
2001	184	154	237	163	207
2011	242	179	346	192	265

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12D - ASSINIBOINE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12D - ASSINIBOINE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	17	17	17	17	17
1991	22	19	23	22	23
2001	26	19	29	25	27
2011	30	18	39	28	34

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12D - ASSINIBOINE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	17	17	17	17	17
1991	22	19	23	22	23
2001	26	19	29	25	27
2011	30	18	39	28	34

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12D - ASSINIBOINE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2	2	2	2	2
1991	3	3	3	3	3
2001	3	3	4	3	4
2011	4	2	5	4	5

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12E - PEMBINA RIVER (MCM/YEAR)

CTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
ricul	5	5	5	5	5
neral	0	0	0	0	0
nufact	0	0	0	0	0
wer	0	0	0	0	0
nicipal	1	1	1	1	1
tal	6	6	6	6	6
1991					
ricul	6	5	6	6	7
neral	0	0	0	0	0
nufact	0	0	0	0	0
wer	0	0	0	0	0
nicipal	1	1	1	1	1
tal	8	6	8	7	8
2001					
ricul	8	5	8	6	9
neral	0	0	0	0	0
nufact	0	0	0	0	0
wer	0	0	0	0	0
nicipal	1	1	1	1	1
tal	9	6	10	8	11
2011					
ricul	9	4	10	7	11
neral	0	0	0	0	0
nufact	0	0	0	0	0
wer	0	0	0	0	0
nicipal	1	1	2	1	2
tal	11	6	12	9	13

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011, BASIN 12E - PEMBINA RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	5	5	5	5	5
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	6	6	6	6	6
1991					
Agricul	6	5	6	6	7
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	8	7	8	7	8
2001					
Agricul	8	5	8	6	9
Mineral	0	0	0	0	0
Manufact	1	0	1	0	1
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	9	6	10	8	11
2011					
Agricul	9	4	10	7	11
Mineral	0	0	0	0	0
Manufact	1	0	1	1	1
Power	0	0	0	0	0
Municipal	1	1	2	1	2
Total	11	6	12	9	14

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 12E - PEMBINA RIVER (MCM/YEAR)

ECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
gricul	4	4	4	4	4
ineral	0	0	0	0	0
anufact	0	0	0	0	0
ower	0	0	0	0	0
unicipal	0	0	0	0	0
otal	4	4	4	4	4
1991					
gricul	5	4	5	5	6
ineral	0	0	0	0	0
anufact	0	0	0	0	0
ower	0	0	0	0	0
unicipal	0	0	0	0	0
otal	5	4	5	5	6
2001					
gricul	6	4	6	5	7
ineral	0	0	0	0	0
anufact	0	0	0	0	0
ower	0	0	0	0	0
unicipal	0	0	0	0	0
otal	6	4	6	5	7
2011					
gricul	8	4	8	6	9
ineral	0	0	0	0	0
anufact	0	0	0	0	0
ower	0	0	0	0	0
unicipal	0	0	0	0	0
otal	8	4	8	6	9

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12E - PEMBINA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	5	5	5	5	5
1991	6	5	6	6	7
2001	8	5	8	6	9
2011	9	4	10	7	11

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12E - PEMBINA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	5	5	5	5	5
1991	6	5	6	6	7
2001	8	5	8	6	9
2011	9	4	10	7	11

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12E - PEMBINA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4	4	4	4	4
1991	5	4	5	5	6
2001	6	4	6	5	7
2011	8	4	8	6	9

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12E - PEMBINA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12E - PEMBINA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12E - PEMBINA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

MMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
SIN 12E - PEMBINA RIVER (MCM/YEAR)

AR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

MMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
SIN 12E - PEMBINA RIVER (MCM/YEAR)

AR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	1	0	1	0	1
2011	1	0	1	1	1

MMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
SIN 12E - PEMBINA RIVER (MCM/YEAR)

AR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

MMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
SIN 12E - PEMBINA RIVER (MCM/YEAR)

AR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

MMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
SIN 12E - PEMBINA RIVER (MCM/YEAR)

AR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

MMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
SIN 12E - PEMBINA RIVER (MCM/YEAR)

AR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12E - PEMBINA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	1	1	1	1	1
2011	1	1	2	1	2

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12E - PEMBINA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	1	1	1	1	1
2011	1	1	2	1	2

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12E - PEMBINA RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12F - RED RIVER (MCM/YEAR)

ECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
gricul	12	12	12	12	12
ineral	0	0	0	0	0
anufact	17	17	17	17	17
ower	0	0	0	0	0
unicipal	102	102	102	102	102
otal	131	131	131	131	131
1991					
gricul	16	14	16	15	17
ineral	0	0	0	0	0
anufact	23	20	24	21	25
ower	0	0	0	0	0
unicipal	138	120	144	134	141
otal	177	154	184	170	183
2001					
gricul	20	13	20	16	23
ineral	0	0	0	0	0
anufact	30	21	32	25	34
ower	0	0	0	0	0
unicipal	160	118	181	153	170
otal	209	152	233	195	227
2011					
gricul	24	11	24	18	29
ineral	0	0	0	0	0
anufact	38	21	44	29	43
ower	0	0	0	0	0
unicipal	189	109	242	171	208
otal	251	141	310	219	281

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011, BASIN 12F - RED RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	12	12	12	12	12
Mineral	0	0	0	0	0
Manufact	86	86	86	86	86
Power	0	0	0	0	0
Municipal	102	102	102	102	102
Total	201	201	201	201	201
1991					
Agricul	16	14	16	15	17
Mineral	0	0	0	0	0
Manufact	117	100	123	109	126
Power	0	0	0	0	0
Municipal	138	120	144	134	141
Total	271	234	282	257	284
2001					
Agricul	20	13	20	16	23
Mineral	0	0	0	0	0
Manufact	161	111	172	131	175
Power	0	0	0	0	0
Municipal	160	118	181	153	170
Total	341	242	373	301	368
2011					
Agricul	24	11	24	18	29
Mineral	0	0	0	0	0
Manufact	224	114	247	153	226
Power	0	0	0	0	0
Municipal	189	109	242	171	208
Total	437	235	514	342	464

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 12F - RED RIVER (MCM/YEAR)

ECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
gricul	10	10	10	10	10
ineral	0	0	0	0	0
anufact	2	2	2	2	2
ower	0	0	0	0	0
unicipal	15	15	15	15	15
otal	28	28	28	28	28
1991					
gricul	13	11	13	12	14
ineral	0	0	0	0	0
anufact	3	3	3	3	4
ower	0	0	0	0	0
unicipal	19	16	19	18	19
otal	35	30	36	33	37
2001					
gricul	16	11	16	13	19
ineral	0	0	0	0	0
anufact	4	3	5	3	5
ower	0	0	0	0	0
unicipal	22	16	24	20	23
Total	42	29	45	37	47
2011					
Agricul	19	9	20	15	23
Mineral	0	0	0	0	0
Manufact	6	3	6	4	7
Power	0	0	0	0	0
Municipal	25	15	32	23	29
Total	50	27	58	42	58

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12F - RED RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	12	12	12	12	12
1991	16	14	16	15	17
2001	20	13	20	16	23
2011	24	11	24	18	29

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12F - RED RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	12	12	12	12	12
1991	16	14	16	15	17
2001	20	13	20	16	23
2011	24	11	24	18	29

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12F - RED RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	10	10	10	10	10
1991	13	11	13	12	14
2001	16	11	16	13	19
2011	19	9	20	15	23

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12F - RED RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12F - RED RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12F - RED RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

UMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
ASIN 12F - RED RIVER (MCM/YEAR)

EAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	17	17	17	17	17
1991	23	20	24	21	25
2001	30	21	32	25	34
2011	38	21	44	29	43

UMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
ASIN 12F - RED RIVER (MCM/YEAR)

EAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	86	86	86	86	86
1991	117	100	123	109	126
2001	161	111	172	131	175
2011	224	114	247	153	226

UMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
ASIN 12F - RED RIVER (MCM/YEAR)

EAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2	2	2	2	2
1991	3	3	3	3	4
2001	4	3	5	3	5
2011	6	3	6	4	7

UMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
ASIN 12F - RED RIVER (MCM/YEAR)

EAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

UMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
ASIN 12F - RED RIVER (MCM/YEAR)

EAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

UMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
ASIN 12F - RED RIVER (MCM/YEAR)

EAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 12F - RED RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	102	102	102	102	102
1991	138	120	144	134	141
2001	160	116	181	153	170
2011	189	109	242	171	208

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12F - RED RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	102	102	102	102	102
1991	138	120	144	134	141
2001	160	118	181	153	170
2011	189	109	242	171	208

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 12F - RED RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	15	15	15	15	15
1991	19	16	19	18	19
2001	22	16	24	20	23
2011	25	15	32	23	29

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN PRAIRIE REGION (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	1	1	1	1	1
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	9	9	9	9	9
Total	10	10	10	10	10
1991					
Agricul	1	1	1	1	1
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	13	11	13	12	13
Total	14	12	14	13	14
2001					
Agricul	1	1	1	1	2
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	15	11	17	14	15
Total	16	12	18	15	17
2011					
Agricul	2	1	2	1	2
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	17	10	23	16	18
Total	19	11	24	17	20

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 13 - WINNIPEG RIVER IN PRAIRIE REGION (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	1	1	1	1	1
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	9	9	9	9	9
Total	10	10	10	10	10
1991					
Agricul	1	1	1	1	1
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	13	11	13	12	13
Total	14	12	14	13	14
2001					
Agricul	1	1	1	1	2
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	15	11	17	14	15
Total	16	12	18	15	17
2011					
Agricul	2	1	2	1	2
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	17	10	23	16	18
Total	19	11	24	17	20

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN PRAIRIE REGION (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	1	1	1	1	1
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	2	2	2	2	2
1991					
Agricul	1	1	1	1	1
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	2	1	2	2	2
Total	3	2	3	2	3
2001					
Agricul	1	1	1	1	1
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	2	1	2	2	2
Total	3	2	3	3	3
2011					
Agricul	1	1	1	1	2
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	2	1	3	2	2
Total	4	2	4	3	4

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	1	1	1	1	2
2011	2	1	2	1	2

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	1	1	1	1	2
2011	2	1	2	1	2

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	1	1	1	1	1
2011	1	1	1	1	2

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	9	9	9	9	9
1991	13	11	13	12	13
2001	15	11	17	14	15
2011	17	10	23	16	18

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	9	9	9	9	9
1991	13	11	13	12	13
2001	15	11	17	14	15
2011	17	10	23	16	18

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN PRAIRIE REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	2	1	2	2	2
2001	2	1	2	2	2
2011	2	1	3	2	2

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 14A - LOWER SASKATCHEWAN RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	5	5	5	5	5
Mineral	2	2	2	2	2
Manufact	12	12	12	12	12
Power	0	0	0	0	0
Municipal	6	6	6	6	6
Total	25	25	25	25	25
1991					
Agricul	7	6	7	6	7
Mineral	2	2	2	2	3
Manufact	16	14	17	15	18
Power	0	0	0	0	0
Municipal	9	7	9	8	9
Total	34	29	34	31	36
2001					
Agricul	8	6	8	7	10
Mineral	3	3	3	3	4
Manufact	23	15	24	20	26
Power	0	0	0	0	0
Municipal	10	7	11	10	10
Total	44	30	46	39	50
2011					
Agricul	10	5	10	8	12
Mineral	4	3	3	3	5
Manufact	32	14	34	25	35
Power	0	0	0	0	0
Municipal	12	7	15	11	12
Total	59	29	63	47	64

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 14A - LOWER SASKATCHEWAN RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	5	5	5	5	5
Mineral	2	2	2	2	2
Manufact	29	29	29	29	29
Power	0	0	0	0	0
Municipal	6	6	6	6	6
Total	42	42	42	42	42
1991					
Agricul	7	6	7	6	7
Mineral	2	2	2	2	3
Manufact	41	35	42	38	45
Power	0	0	0	0	0
Municipal	9	7	9	8	9
Total	59	50	60	54	64
2001					
Agricul	8	6	8	7	10
Mineral	3	3	3	3	4
Manufact	57	37	60	50	65
Power	0	0	0	0	0
Municipal	10	7	11	10	10
Total	79	53	82	69	89
2011					
Agricul	10	5	10	8	12
Mineral	5	3	4	4	5
Manufact	79	35	84	61	86
Power	0	0	0	0	0
Municipal	12	7	15	11	12
Total	106	50	113	83	116

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 14A - LOWER SASKATCHEWAN RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	4	4	4	4	4
Mineral	0	0	0	0	0
Manufact	1	1	1	1	1
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	6	6	6	6	6
1991					
Agricul	5	5	5	5	6
Mineral	0	0	0	0	0
Manufact	1	1	1	1	1
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	8	7	8	7	9
2001					
Agricul	7	4	7	6	8
Mineral	0	0	0	0	0
Manufact	2	1	2	2	2
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	10	7	10	8	11
2011					
Agricul	8	4	8	6	10
Mineral	0	0	0	0	0
Manufact	2	1	3	2	3
Power	0	0	0	0	0
Municipal	2	1	2	1	2
Total	12	6	13	10	14

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 14A - LOWER SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	5	5	5	5	5
1991	7	6	7	6	7
2001	8	6	8	7	10
2011	10	5	10	8	12

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14A - LOWER SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	5	5	5	5	5
1991	7	6	7	6	7
2001	8	6	8	7	10
2011	10	5	10	8	12

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14A - LOWER SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4	4	4	4	4
1991	5	5	5	5	6
2001	7	4	7	6	8
2011	8	4	8	6	10

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 14A - LOWER SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2	2	2	2	2
1991	2	2	2	2	3
2001	3	3	3	3	4
2011	4	3	3	3	5

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14A - LOWER SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2	2	2	2	2
1991	2	2	2	2	3
2001	3	3	3	3	4
2011	5	3	4	4	5

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14A - LOWER SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 14A - LOWER SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	12	12	12	12	12
1991	16	14	17	15	18
2001	23	15	24	20	26
2011	32	14	34	25	35

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14A - LOWER SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	29	29	29	29	29
1991	41	35	42	38	45
2001	57	37	60	50	65
2011	79	35	84	61	86

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14A - LOWER SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	2	1	2	2	2
2011	2	1	3	2	3

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 14A - LOWER SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14A - LOWER SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14A - LOWER SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 14A - LOWER SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	6	6	6	6	6
1991	9	7	9	8	9
2001	10	7	11	10	10
2011	12	7	15	11	12

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14A - LOWER SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	6	6	6	6	6
1991	9	7	9	8	9
2001	10	7	11	10	10
2011	12	7	15	11	12

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14A - LOWER SASKATCHEWAN RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	1	1	1	1	1
2011	2	1	2	1	2

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 14B - MANITOBA LAKES (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	23	23	23	23	23
Mineral	0	0	0	0	0
Manufact	15	15	15	15	15
Power	0	0	0	0	0
Municipal	4	4	4	4	4
Total	42	42	42	42	42
1991					
gricul	29	25	29	27	32
ineral	0	0	0	0	0
anufact	20	17	26	20	20
ower	0	0	0	0	0
unicipal	6	5	6	6	6
otal	55	47	62	52	58
2001					
gricul	36	24	37	30	42
ineral	0	0	0	0	0
anufact	25	17	34	23	27
ower	0	0	0	0	0
unicipal	7	5	8	7	7
otal	68	46	78	60	77
2011					
gricul	44	21	45	34	53
ineral	0	0	0	0	0
anufact	31	15	44	26	34
ower	0	0	0	0	0
unicipal	8	5	11	7	9
otal	83	41	99	67	96

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 14B - MANITOBA LAKES (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	23	23	23	23	23
Mineral	0	0	0	0	0
Manufact	20	20	20	20	20
Power	0	0	0	0	0
Municipal	4	4	4	4	4
Total	46	46	46	46	46
1991					
Agricul	29	25	29	27	32
Mineral	0	0	0	0	0
Manufact	26	22	33	25	26
Power	0	0	0	0	0
Municipal	6	5	6	6	6
Total	61	52	69	58	64
2001					
Agricul	36	24	37	30	42
Mineral	0	0	0	0	0
Manufact	32	22	43	29	35
Power	0	0	0	0	0
Municipal	7	5	8	7	7
Total	75	51	87	66	85
2011					
Agricul	44	21	45	34	53
Mineral	0	0	0	0	0
Manufact	39	20	56	33	44
Power	0	0	0	0	0
Municipal	8	5	11	7	9
Total	91	45	112	74	105

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14B - MANITOBA LAKES (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	18	18	18	18	18
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	19	19	19	19	19
1991					
Agricul	24	20	24	22	26
Mineral	0	0	0	0	0
Manufact	1	1	1	1	1
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	25	21	25	23	27
2001					
Agricul	29	19	30	25	34
Mineral	0	0	0	0	0
Manufact	1	1	1	1	1
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	31	21	31	26	36
2011					
Agricul	35	17	36	27	43
Mineral	0	0	0	0	0
Manufact	1	1	1	1	1
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	38	18	39	29	45

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 14B - MANITOBA LAKES (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	23	23	23	23	23
1991	29	25	29	27	32
2001	36	24	37	30	42
2011	44	21	45	34	53

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14B - MANITOBA LAKES (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	23	23	23	23	23
1991	29	25	29	27	32
2001	36	24	37	30	42
2011	44	21	45	34	53

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14B - MANITOBA LAKES (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	18	18	18	18	18
1991	24	20	24	22	26
2001	29	19	30	25	34
2011	35	17	36	27	43

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 14B - MANITOBA LAKES (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14B - MANITOBA LAKES (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14B - MANITOBA LAKES (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 14B - MANITOBA LAKES (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	15	15	15	15	15
1991	20	17	26	20	20
2001	25	17	34	23	27
2011	31	15	44	26	34

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14B - MANITOBA LAKES (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	20	20	20	20	20
1991	26	22	33	25	26
2001	32	22	43	29	35
2011	39	20	56	33	44

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14B - MANITOBA LAKES (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	1	1	1	1	1
2001	1	1	1	1	1
2011	1	1	1	1	1

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 14B - MANITOBA LAKES (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14B - MANITOBA LAKES (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14B - MANITOBA LAKES (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 14B - MANITOBA LAKES (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4	4	4	4	4
1991	6	5	6	6	6
2001	7	5	8	7	7
2011	8	5	11	7	9

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14B - MANITOBA LAKES (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4	4	4	4	4
1991	6	5	6	6	6
2001	7	5	8	7	7
2011	8	5	11	7	9

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14B - MANITOBA LAKES (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	1	1	1	1	1
2011	1	1	1	1	1

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 14C - NELSON RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	3	3	3	3	3
Manufact	45	45	45	45	45
Power	0	0	0	0	0
Municipal	3	3	3	3	3
Total	51	51	51	51	51
1991					
Agricul	0	0	0	0	0
Mineral	4	3	3	3	4
Manufact	64	53	65	58	70
Power	0	0	0	0	0
Municipal	4	4	5	4	4
Total	72	60	72	65	78
2001					
Agricul	0	0	0	0	0
Mineral	5	4	4	4	6
Manufact	90	57	92	78	102
Power	0	0	0	0	0
Municipal	5	4	6	5	5
Total	100	65	102	87	113
2011					
Agricul	0	0	0	0	0
Mineral	7	5	5	5	7
Manufact	126	53	132	97	136
Power	0	0	0	0	0
Municipal	6	4	8	6	6
Total	139	62	146	108	150

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011, BASIN 14C - NELSON RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	3	3	3	3	3
Manufact	72	72	72	72	72
Power	0	0	0	0	0
Municipal	3	3	3	3	3
Total	78	78	78	78	78
1991					
Agricul	0	0	0	0	0
Mineral	4	3	3	3	4
Manufact	103	86	105	94	113
Power	0	0	0	0	0
Municipal	4	4	5	4	4
Total	112	93	113	102	122
2001					
Agricul	0	0	0	0	0
Mineral	5	4	4	5	6
Manufact	146	93	150	126	166
Power	0	0	0	0	0
Municipal	5	4	6	5	5
Total	156	101	160	136	177
2011					
Agricul	0	0	0	0	0
Mineral	7	5	6	6	8
Manufact	205	87	215	158	221
Power	0	0	0	0	0
Municipal	6	4	8	6	6
Total	219	96	229	170	235

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 14C - NELSON RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	0	0	0	0	0
1991					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	1	1	1	1	1
2001					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	1	0	1	1	1
Total	1	0	1	1	1
2011					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	1	0	1	1	1
Total	1	0	1	1	1

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 14C - NELSON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14C - NELSON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14C - NELSON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 14C - NELSON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3	3	3	3	3
1991	4	3	3	3	4
2001	5	4	4	4	6
2011	7	5	5	5	7

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14C - NELSON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3	3	3	3	3
1991	4	3	3	3	4
2001	5	4	4	5	6
2011	7	5	6	6	8

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14C - NELSON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 14C - NELSON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	45	45	45	45	45
1991	64	53	65	58	70
2001	90	57	92	78	102
2011	126	53	132	97	136

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14C - NELSON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	72	72	72	72	72
1991	103	86	105	94	113
2001	146	93	150	126	166
2011	205	87	215	158	221

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14C - NELSON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 14C - NELSON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14C - NELSON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14C - NELSON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 14C - NELSON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3	3	3	3	3
1991	4	4	5	4	4
2001	5	4	6	5	5
2011	6	4	8	6	6

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14C - NELSON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3	3	3	3	3
1991	4	4	5	4	4
2001	5	4	6	5	5
2011	6	4	8	6	6

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 14C - NELSON RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	1	1	1	1	1
2001	1	0	1	1	1
2011	1	0	1	1	1

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	148	148	148	148	148
Mineral	124	124	124	124	124
Manufact	4577	4577	4577	4577	4577
Power	14930	14930	14930	14930	14930
Municipal	1450	1450	1450	1450	1450
Total	21230	21230	21230	21230	21230
1991					
Agricul	183	154	172	171	195
Mineral	168	155	164	150	187
Manufact	5725	4943	5954	5311	6212
Power	18659	17204	20866	17362	19908
Municipal	1749	1531	1804	1637	1853
Total	26484	23987	28960	24631	28355
2001					
Agricul	220	147	203	190	254
Mineral	222	185	227	189	262
Manufact	7392	5248	7923	6217	8777
Power	23756	19836	28601	21107	26516
Municipal	2050	1509	2221	1790	2336
Total	33640	26925	39176	29493	38146
2011					
Agricul	265	126	248	208	313
Mineral	294	217	336	225	340
Manufact	9578	5138	10684	6986	11420
Power	30309	22353	39552	24497	33356
Municipal	2415	1401	2826	1930	2828
Total	42861	29235	53646	33847	48258

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011, ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	148	148	148	148	148
Mineral	288	288	288	288	288
Manufact	8536	8536	8536	8536	8536
Power	14930	14930	14930	14930	14930
Municipal	1450	1450	1450	1450	1450
Total	25352	25352	25352	25352	25352
1991					
Agricul	183	154	172	171	195
Mineral	391	360	357	349	435
Manufact	10681	9176	10970	9875	11612
Power	18659	17204	20866	17362	19908
Municipal	1749	1531	1804	1637	1853
Total	31663	28425	34169	29395	34003
2001					
Agricul	220	147	203	190	254
Mineral	518	433	466	442	611
Manufact	13789	9669	14517	11599	16364
Power	23756	19836	28601	21107	26516
Municipal	2050	1509	2221	1790	2336
Total	40333	31594	46008	35128	46081
2011					
Agricul	265	126	248	208	313
Mineral	689	508	636	526	795
Manufact	17867	9352	19496	13085	21303
Power	30309	22353	39552	24497	33356
Municipal	2415	1401	2826	1930	2828
Total	51545	33740	62757	40245	58595

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	123	123	123	123	123
Mineral	12	12	12	12	12
Manufact	200	200	200	200	200
Power	36	36	36	36	36
Municipal	218	218	218	218	218
Total	589	589	589	589	589
1991					
Agricul	152	151	143	142	162
ineral	16	16	15	14	18
anufact	250	244	266	233	271
Power	45	45	50	42	48
unicipal	262	255	271	245	278
Total	726	711	745	677	776
2001					
gricul	183	122	169	158	211
ineral	21	18	20	18	25
anufact	319	235	355	268	380
ower	57	48	69	51	64
unicipal	307	226	333	268	350
otal	888	649	947	764	1031
2011					
gricul	220	104	206	173	260
ineral	28	21	29	22	33
anufact	409	236	481	299	493
ower	73	54	96	59	81
unicipal	362	210	424	289	424
otal	1093	625	1235	842	1291

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	148	148	148	148	148
1991	183	154	172	171	195
2001	220	147	203	190	254
2011	265	126	248	208	313

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	148	148	148	148	148
1991	183	154	172	171	195
2001	220	147	203	190	254
2011	265	126	248	208	313

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	123	123	123	123	123
1991	152	151	143	142	162
2001	183	122	169	158	211
2011	220	104	206	173	260

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	124	124	124	124	124
1991	168	155	164	150	187
2001	222	185	227	189	262
2011	294	217	336	225	340

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	288	288	288	288	288
1991	391	360	357	349	435
2001	518	433	466	442	611
2011	689	508	636	526	795

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	12	12	12	12	12
1991	16	16	15	14	18
2001	21	18	20	18	25
2011	28	21	29	22	33

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4577	4577	4577	4577	4577
1991	5725	4943	5954	5311	6212
2001	7392	5248	7923	6217	8777
2011	9578	5138	10684	6986	11420

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	8536	8536	8536	8536	8536
1991	10681	9176	10970	9875	11612
2001	13789	9669	14517	11599	16364
2011	17867	9352	19496	13085	21303

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	200	200	200	200	200
1991	250	244	266	233	271
2001	319	235	355	268	380
2011	409	236	481	299	493

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	14930	14930	14930	14930	14930
1991	18659	17204	20866	17362	19908
2001	23756	19836	28601	21107	26516
2011	30309	22353	39552	24497	33356

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	14930	14930	14930	14930	14930
1991	18659	17204	20866	17362	19908
2001	23756	19836	28601	21107	26516
2011	30309	22353	39552	24497	33356

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	36	36	36	36	36
1991	45	45	50	42	48
2001	57	48	69	51	64
2011	73	54	96	59	81

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1450	1450	1450	1450	1450
1991	1749	1531	1804	1637	1853
2001	2050	1509	2221	1790	2336
2011	2415	1401	2826	1930	2828

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1450	1450	1450	1450	1450
1991	1749	1531	1804	1637	1853
2001	2050	1509	2221	1790	2336
2011	2415	1401	2826	1930	2828

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	218	218	218	218	218
1991	262	255	271	245	278
2001	307	226	333	268	350
2011	362	210	424	289	424

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	29	29	29	29	29
Manufact	96	96	96	96	96
Power	0	0	0	0	0
Municipal	8	8	8	8	8
Total	132	132	132	132	132
1991					
Agricul	0	0	0	0	0
Mineral	39	36	34	35	44
Manufact	115	97	112	112	121
Power	0	0	0	0	0
Municipal	9	8	10	9	10
Total	164	142	155	155	175
2001					
Agricul	0	0	0	0	0
Mineral	53	44	42	45	62
Manufact	141	95	135	126	159
Power	0	0	0	0	0
Municipal	11	8	12	9	12
Total	205	147	189	180	233
2011					
Agricul	0	0	0	0	0
Mineral	70	52	51	53	81
Manufact	173	82	164	139	197
Power	0	0	0	0	0
Municipal	13	7	15	10	15
Total	256	141	231	202	292

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 13 - WINNIPEG RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	92	92	92	92	92
Manufact	96	96	96	96	96
Power	0	0	0	0	0
Municipal	8	8	8	8	8
Total	196	196	196	196	196
1991					
Agricul	0	0	0	0	0
Mineral	125	115	107	111	139
Manufact	116	98	113	112	122
Power	0	0	0	0	0
Municipal	9	8	10	9	10
Total	250	221	229	232	270
2001					
Agricul	0	0	0	0	0
Mineral	166	138	131	141	195
Manufact	142	95	136	127	160
Power	0	0	0	0	0
Municipal	11	8	12	9	12
Total	319	242	279	278	368
2011					
Agricul	0	0	0	0	0
Mineral	221	163	162	168	254
Manufact	175	83	165	140	198
Power	0	0	0	0	0
Municipal	13	7	15	10	15
Total	409	253	343	318	467

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 13 - WINNIPEG RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	2	2	2	2	2
1991					
gricul	0	0	0	0	0
ineral	0	0	0	0	0
anufact	0	0	0	0	0
ower	0	0	0	0	0
unicipal	1	1	1	1	1
otal	2	2	2	2	2
2001					
gricul	0	0	0	0	0
ineral	0	0	0	0	0
anufact	1	0	1	0	1
ower	0	0	0	0	0
unicipal	2	1	2	1	2
otal	2	2	2	2	2
2011					
gricul	0	0	0	0	0
ineral	0	0	0	0	0
anufact	1	0	1	1	1
ower	0	0	0	0	0
unicipal	2	1	2	2	2
otal	3	1	3	2	3

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	29	29	29	29	29
1991	39	36	34	35	44
2001	53	44	42	45	62
2011	70	52	51	53	81

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	92	92	92	92	92
1991	125	115	107	111	139
2001	166	138	131	141	195
2011	221	163	162	168	254

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	96	96	96	96	96
1991	115	97	112	112	121
2001	141	95	135	126	159
2011	173	82	164	139	197

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	96	96	96	96	96
1991	116	98	113	112	122
2001	142	95	136	127	160
2011	175	83	165	140	198

UMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
ASIN 13 - WINNIPEG RIVER IN ONTARIO REGION (MCM/YEAR)

EAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	1	0	1	0	1
2011	1	0	1	1	1

UMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
ASIN 13 - WINNIPEG RIVER IN ONTARIO REGION (MCM/YEAR)

EAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

MMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
SIN 13 - WINNIPEG RIVER IN ONTARIO REGION (MCM/YEAR)

AR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

MMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
SIN 13 - WINNIPEG RIVER IN ONTARIO REGION (MCM/YEAR)

AR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	8	8	8	8	8
1991	9	8	10	9	10
2001	11	8	12	9	12
2011	13	7	15	10	15

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	8	8	8	8	8
1991	9	8	10	9	10
2001	11	8	12	9	12
2011	13	7	15	10	15

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 13 - WINNIPEG RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	2	1	2	1	2
2011	2	1	2	2	2

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 17 - NORTHERN ONTARIO (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	10	10	10	10	10
Manufact	101	101	101	101	101
Power	0	0	0	0	0
Municipal	15	15	15	15	15
Total	126	126	126	126	126
1991					
gricul	0	0	0	0	0
ineral	14	13	12	13	16
anufact	122	103	119	118	129
ower	0	0	0	0	0
unicipal	17	15	18	16	18
otal	154	131	149	147	163
2001					
gricul	0	0	0	0	0
ineral	19	16	15	16	22
anufact	151	101	145	134	171
ower	0	0	0	0	0
unicipal	20	15	22	18	23
otal	190	131	182	168	216
2011					
gricul	0	0	0	0	0
ineral	25	18	18	19	29
anufact	187	88	178	148	212
ower	0	0	0	0	0
unicipal	24	14	29	19	28
otal	236	120	225	187	269

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011, BASIN 17 - NORTHERN ONTARIO (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	14	14	14	14	14
Manufact	308	308	308	308	308
Power	0	0	0	0	0
Municipal	15	15	15	15	15
Total	337	337	337	337	337
1991					
Agricul	0	0	0	0	0
Mineral	19	17	16	17	21
Manufact	374	315	364	359	395
Power	0	0	0	0	0
Municipal	17	15	18	16	18
Total	410	348	398	392	434
2001					
Agricul	0	0	0	0	0
Mineral	25	21	20	21	30
Manufact	466	310	448	412	527
Power	0	0	0	0	0
Municipal	20	15	22	18	23
Total	511	346	491	451	580
2011					
Agricul	0	0	0	0	0
Mineral	34	25	25	26	39
Manufact	582	271	556	457	660
Power	0	0	0	0	0
Municipal	24	14	29	19	28
Total	639	310	609	502	726

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 17 - NORTHERN ONTARIO (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	2	2	2	2	2
Total	2	2	2	2	2
1991					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	3	3	3	2	3
Total	3	3	3	3	3
2001					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	3	2	3	3	3
Total	3	2	4	3	4
2011					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	4	2	4	3	4
Total	4	2	5	3	5

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 17 - NORTHERN ONTARIO (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 17 - NORTHERN ONTARIO (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 17 - NORTHERN ONTARIO (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 17 - NORTHERN ONTARIO (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	10	10	10	10	10
1991	14	13	12	13	16
2001	19	16	15	16	22
2011	25	18	18	19	29

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2
BASIN 17 - NORTHERN ONTARIO (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	14	14	14	14	14
1991	19	17	16	17	21
2001	25	21	20	21	30
2011	34	25	25	26	39

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2
BASIN 17 - NORTHERN ONTARIO (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 17 - NORTHERN ONTARIO (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	101	101	101	101	101
1991	122	103	119	118	129
2001	151	101	145	134	171
2011	187	88	178	148	212

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 17 - NORTHERN ONTARIO (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	308	308	308	308	308
1991	374	315	364	359	395
2001	466	310	448	412	527
2011	582	271	556	457	660

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 17 - NORTHERN ONTARIO (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 17 - NORTHERN ONTARIO (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 17 - NORTHERN ONTARIO (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 17 - NORTHERN ONTARIO (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 17 - NORTHERN ONTARIO (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	15	15	15	15	15
1991	17	15	18	16	18
2001	20	15	22	18	23
2011	24	14	29	19	28

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 17 - NORTHERN ONTARIO (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	15	15	15	15	15
1991	17	15	18	16	18
2001	20	15	22	18	23
2011	24	14	29	19	28

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 17 - NORTHERN ONTARIO (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2	2	2	2	2
1991	3	3	3	2	3
2001	3	2	3	3	3
2011	4	2	4	3	4

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19A - LAKE SUPERIOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	3	3	3	3	3
Mineral	13	13	13	13	13
Manufact	185	185	185	185	185
Power	292	292	292	292	292
Municipal	26	26	26	26	26
Total	519	519	519	519	519
1991					
Agricul	3	3	3	3	3
Mineral	18	17	16	16	20
Manufact	223	188	217	215	234
Power	365	337	408	340	390
Municipal	31	28	32	29	33
Total	641	572	676	604	681
2001					
Agricul	4	3	4	3	5
Mineral	24	20	19	21	29
Manufact	273	183	262	244	308
Power	465	388	560	413	519
Municipal	37	27	40	32	42
Total	803	621	885	713	902
2011					
Agricul	5	2	4	4	6
Mineral	32	24	24	25	37
Manufact	336	160	319	269	380
Power	593	437	774	479	653
Municipal	43	25	51	35	51
Total	1009	648	1172	811	1127

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 19A - LAKE SUPERIOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	3	3	3	3	3
Mineral	17	17	17	17	17
Manufact	426	426	426	426	426
Power	292	292	292	292	292
Municipal	26	26	26	26	26
Total	764	764	764	764	764
1991					
Agricul	3	3	3	3	3
Mineral	23	22	20	21	26
Manufact	514	434	499	496	539
Power	365	337	408	340	390
Municipal	31	28	32	29	33
Total	937	822	963	890	992
2001					
Agricul	4	3	4	3	5
Mineral	31	26	25	27	37
Manufact	630	422	603	562	709
Power	465	388	560	413	519
Municipal	37	27	40	32	42
Total	1166	866	1231	1037	1311
2011					
Agricul	5	2	4	4	6
Mineral	42	31	31	32	48
Manufact	773	367	732	619	875
Power	593	437	774	479	653
Municipal	43	25	51	35	51
Total	1456	863	1592	1168	1632

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19A - LAKE SUPERIOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	2	2	2	2	2
Mineral	7	7	7	7	7
Manufact	2	2	2	2	2
Power	1	1	1	1	1
Municipal	4	4	4	4	4
Total	16	16	16	16	16
1991					
Agricul	3	3	3	3	3
Mineral	10	10	8	9	11
Manufact	3	3	3	3	3
Power	1	1	1	1	1
Municipal	5	5	5	4	5
Total	21	21	20	19	23
2001					
Agricul	3	2	3	3	4
Mineral	13	11	10	11	15
Manufact	4	2	3	3	4
Power	1	1	1	1	1
Municipal	6	4	6	5	6
Total	26	21	24	23	31
2011					
Agricul	4	2	4	3	5
Mineral	17	13	13	13	20
Manufact	4	2	4	3	5
Power	1	1	2	1	2
Municipal	7	4	8	5	8
Total	34	22	30	26	39

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19A - LAKE SUPERIOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3	3	3	3	3
1991	3	3	3	3	3
2001	4	3	4	3	5
2011	5	2	4	4	6

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19A - LAKE SUPERIOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3	3	3	3	3
1991	3	3	3	3	3
2001	4	3	4	3	5
2011	5	2	4	4	6

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19A - LAKE SUPERIOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2	2	2	2	2
1991	3	3	3	3	3
2001	3	2	3	3	4
2011	4	2	4	3	5

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19A - LAKE SUPERIOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	13	13	13	13	13
1991	18	17	16	16	20
2001	24	20	19	21	29
2011	32	24	24	25	37

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2(
BASIN 19A - LAKE SUPERIOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	17	17	17	17	17
1991	23	22	20	21	26
2001	31	26	25	27	37
2011	42	31	31	32	48

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2(
BASIN 19A - LAKE SUPERIOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	7	7	7	7	7
1991	10	10	8	9	11
2001	13	11	10	11	15
2011	17	13	13	13	20

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19A - LAKE SUPERIOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	185	185	185	185	185
1991	223	188	217	215	234
2001	273	183	262	244	308
2011	336	160	319	269	380

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19A - LAKE SUPERIOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	426	426	426	426	426
1991	514	434	499	496	539
2001	630	422	603	562	709
2011	773	367	732	619	875

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19A - LAKE SUPERIOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2	2	2	2	2
1991	3	3	3	3	3
2001	4	2	3	3	4
2011	4	2	4	3	5

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19A - LAKE SUPERIOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	292	292	292	292	292
1991	365	337	408	340	390
2001	465	388	560	413	519
2011	593	437	774	479	653

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19A - LAKE SUPERIOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	292	292	292	292	292
1991	365	337	408	340	390
2001	465	388	560	413	519
2011	593	437	774	479	653

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19A - LAKE SUPERIOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	1	1	1	1	1
2011	1	1	2	1	2

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19A - LAKE SUPERIOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	26	26	26	26	26
1991	31	28	32	29	33
2001	37	27	40	32	42
2011	43	25	51	35	51

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19A - LAKE SUPERIOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	26	26	26	26	26
1991	31	28	32	29	33
2001	37	27	40	32	42
2011	43	25	51	35	51

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19A - LAKE SUPERIOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4	4	4	4	4
1991	5	5	5	4	5
2001	6	4	6	5	6
2011	7	4	8	5	8

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19B - LAKE HURON (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	38	38	38	38	38
Mineral	35	35	35	35	35
Manufact	1299	1299	1299	1299	1299
Power	5300	5300	5300	5300	5300
Municipal	120	120	120	120	120
Total	6793	6793	6793	6793	6793
1991					
Agricul	47	40	45	44	51
Mineral	48	44	46	42	53
Manufact	1624	1404	1709	1506	1762
Power	6624	6108	7408	6164	7068
Municipal	145	127	149	135	153
Total	8488	7722	9357	7892	9087
2001					
Agricul	57	38	53	49	66
Mineral	63	52	64	54	74
Manufact	2119	1507	2313	1775	2518
Power	8434	7042	10154	7493	9414
Municipal	169	125	184	148	193
Total	10842	8765	12767	9519	12265
2011					
Agricul	69	33	64	54	81
Mineral	83	61	94	64	96
Manufact	2773	1491	3164	2003	3295
Power	10760	7935	14042	8697	11842
Municipal	200	116	234	160	234
Total	13884	9636	17598	10977	15549

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 19B - LAKE HURON (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	38	38	38	38	38
Mineral	79	79	79	79	79
Manufact	2096	2096	2096	2096	2096
Power	5300	5300	5300	5300	5300
Municipal	120	120	120	120	120
Total	7634	7634	7634	7634	7634
1991					
Agricul	47	40	45	44	51
Mineral	108	99	98	96	120
Manufact	2605	2228	2671	2401	2845
Power	6624	6108	7408	6164	7068
Municipal	145	127	149	135	153
Total	9529	8602	10371	8840	10236
2001					
Agricul	57	38	53	49	66
Mineral	143	119	127	122	168
Manufact	3402	2356	3571	2862	4037
Power	8434	7042	10154	7493	9414
Municipal	169	125	184	148	193
Total	12205	9681	14089	10675	13878
2011					
Agricul	69	33	64	54	81
Mineral	190	140	173	145	219
Manufact	4457	2267	4828	3275	5289
Power	10760	7935	14042	8697	11842
Municipal	200	116	234	160	234
Total	15676	10491	19340	12330	17665

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011, BASIN 19B - LAKE HURON (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	32	32	32	32	32
Mineral	3	3	3	3	3
Manufact	11	11	11	11	11
Power	13	13	13	13	13
Municipal	18	18	18	18	18
Total	76	76	76	76	76
1991					
Agricul	39	39	37	37	42
Mineral	4	4	3	3	4
Manufact	14	13	14	13	15
Power	16	16	18	15	17
Municipal	22	21	22	20	23
Total	95	93	94	88	101
2001					
Agricul	47	32	44	41	55
Mineral	5	4	4	4	6
Manufact	18	12	19	16	21
Power	20	17	25	18	23
Municipal	25	19	28	22	29
Total	117	84	119	101	134
2011					
Agricul	57	27	53	45	68
Mineral	7	5	5	5	7
Manufact	25	11	26	18	28
Power	26	19	34	21	29
Municipal	30	17	35	24	35
Total	144	79	153	113	167

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19B - LAKE HURON (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	38	38	38	38	38
1991	47	40	45	44	51
2001	57	38	53	49	66
2011	69	33	64	54	81

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19B - LAKE HURON (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	38	38	38	38	38
1991	47	40	45	44	51
2001	57	38	53	49	66
2011	69	33	64	54	81

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19B - LAKE HURON (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	32	32	32	32	32
1991	39	39	37	37	42
2001	47	32	44	41	55
2011	57	27	53	45	68

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19B - LAKE HURON (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	35	35	35	35	35
1991	48	44	46	42	53
2001	63	52	64	54	74
2011	83	61	94	64	96

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2
BASIN 19B - LAKE HURON (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	79	79	79	79	79
1991	108	99	98	96	120
2001	143	119	127	122	168
2011	190	140	173	145	219

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2
BASIN 19B - LAKE HURON (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3	3	3	3	3
1991	4	4	3	3	4
2001	5	4	4	4	6
2011	7	5	5	5	7

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19B - LAKE HURON (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1299	1299	1299	1299	1299
1991	1624	1404	1709	1506	1762
2001	2119	1507	2313	1775	2518
2011	2773	1491	3164	2003	3295

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19B - LAKE HURON (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2096	2096	2096	2096	2096
1991	2605	2228	2671	2401	2845
2001	3402	2356	3571	2862	4037
2011	4457	2267	4828	3275	5289

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19B - LAKE HURON (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	11	11	11	11	11
1991	14	13	14	13	15
2001	18	12	19	16	21
2011	25	11	26	18	28

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19B - LAKE HURON (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	5300	5300	5300	5300	5300
1991	6624	6108	7408	6164	7068
2001	8434	7042	10154	7493	9414
2011	10760	7935	14042	8697	11842

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19B - LAKE HURON (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	5300	5300	5300	5300	5300
1991	6624	6108	7408	6164	7068
2001	8434	7042	10154	7493	9414
2011	10760	7935	14042	8697	11842

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19B - LAKE HURON (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	13	13	13	13	13
1991	16	16	18	15	17
2001	20	17	25	18	23
2011	26	19	34	21	29

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19B - LAKE HURON (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	120	120	120	120	120
1991	145	127	149	135	153
2001	169	125	184	148	193
2011	200	116	234	160	234

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19B - LAKE HURON (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	120	120	120	120	120
1991	145	127	149	135	153
2001	169	125	184	148	193
2011	200	116	234	160	234

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19B - LAKE HURON (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	18	18	18	18	18
1991	22	21	22	20	23
2001	25	19	28	22	29
2011	30	17	35	24	35

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19C - LAKES ST. CLAIR & ERIE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	46	46	46	46	46
Mineral	11	11	11	11	11
Manufact	1363	1363	1363	1363	1363
Power	4608	4608	4608	4608	4608
Municipal	272	272	272	272	272
Total	6300	6300	6300	6300	6300
1991					
Agricul	57	48	54	54	61
Mineral	14	13	25	12	16
Manufact	1716	1513	1856	1586	1872
Power	5758	5309	6439	5358	6144
Municipal	329	288	339	307	348
Total	7874	7171	8712	7317	8441
2001					
Agricul	69	46	64	60	80
Mineral	17	15	47	15	21
Manufact	2181	1637	2489	1809	2636
Power	7331	6122	8826	6514	8183
Municipal	385	283	417	336	439
Total	9983	8103	11843	8733	11359
2011					
Agricul	83	39	78	65	98
Mineral	22	16	94	18	27
Manufact	2776	1674	3376	2001	3418
Power	9353	6898	12206	7560	10294
Municipal	454	263	530	362	531
Total	12689	8891	16284	10007	14368

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011, BASIN 19C - LAKES ST. CLAIR & ERIE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	46	46	46	46	46
Mineral	11	11	11	11	11
Manufact	2282	2282	2282	2282	2282
Power	4608	4608	4608	4608	4608
Municipal	272	272	272	272	272
Total	7220	7220	7220	7220	7220
1991					
Agricul	57	48	54	54	61
Mineral	15	13	26	13	16
Manufact	2901	2526	3084	2651	3191
Power	5758	5309	6439	5358	6144
Municipal	329	288	339	307	348
Total	9060	8185	9942	8383	9760
2001					
Agricul	69	46	64	60	80
Mineral	18	15	50	16	22
Manufact	3712	2694	4133	3056	4503
Power	7331	6122	8826	6514	8183
Municipal	385	283	417	336	439
Total	11516	9161	13490	9981	13226
2011					
Agricul	83	39	78	65	98
Mineral	23	17	99	19	28
Manufact	4760	2677	5620	3406	5860
Power	9353	6898	12206	7560	10294
Municipal	454	263	530	362	531
Total	14673	9895	18533	11412	16812

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19C - LAKES ST. CLAIR & ERIE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	38	38	38	38	38
Mineral	1	1	1	1	1
Manufact	127	127	127	127	127
Power	11	11	11	11	11
Municipal	41	41	41	41	41
Total	218	218	218	218	218
1991					
Agricul	48	47	45	45	51
Mineral	1	1	3	1	2
Manufact	158	154	172	147	172
Power	14	14	16	13	15
Municipal	49	48	51	46	52
Total	270	265	286	252	291
2001					
Agricul	57	38	53	50	66
Mineral	2	2	5	2	2
Manufact	201	152	232	168	242
Power	18	15	21	16	20
Municipal	58	43	63	50	66
Total	336	249	374	285	396
2011					
Agricul	69	33	64	54	82
Mineral	2	2	10	2	3
Manufact	256	156	317	186	313
Power	23	17	30	18	25
Municipal	68	39	80	54	80
Total	418	247	501	315	502

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19C - LAKES ST. CLAIR & ERIE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	46	46	46	46	46
1991	57	48	54	54	61
2001	69	46	64	60	80
2011	83	39	78	65	98

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19C - LAKES ST. CLAIR & ERIE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	46	46	46	46	46
1991	57	48	54	54	61
2001	69	46	64	60	80
2011	83	39	78	65	98

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19C - LAKES ST. CLAIR & ERIE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	38	38	38	38	38
1991	48	47	45	45	51
2001	57	38	53	50	66
2011	69	33	64	54	82

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19C - LAKES ST. CLAIR & ERIE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	11	11	11	11	11
1991	14	13	25	12	16
2001	17	15	47	15	21
2011	22	16	94	18	27

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-20
BASIN 19C - LAKES ST. CLAIR & ERIE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	11	11	11	11	11
1991	15	13	26	13	16
2001	18	15	50	16	22
2011	23	17	99	19	28

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-20
BASIN 19C - LAKES ST. CLAIR & ERIE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	3	1	2
2001	2	2	5	2	2
2011	2	2	10	2	3

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19C - LAKES ST. CLAIR & ERIE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1363	1363	1363	1363	1363
1991	1716	1513	1856	1586	1872
2001	2181	1637	2489	1809	2636
2011	2776	1674	3376	2001	3418

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19C - LAKES ST. CLAIR & ERIE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2282	2282	2282	2282	2282
1991	2901	2526	3084	2651	3191
2001	3712	2694	4133	3056	4503
2011	4760	2677	5620	3406	5860

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19C - LAKES ST. CLAIR & ERIE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	127	127	127	127	127
1991	158	154	172	147	172
2001	201	152	232	168	242
2011	256	156	317	186	313

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19C - LAKES ST. CLAIR & ERIE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4608	4608	4608	4608	4608
1991	5758	5309	6439	5358	6144
2001	7331	6122	8826	6514	8183
2011	9353	6898	12206	7560	10294

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19C - LAKES ST. CLAIR & ERIE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4608	4608	4608	4608	4608
1991	5758	5309	6439	5358	6144
2001	7331	6122	8826	6514	8183
2011	9353	6898	12206	7560	10294

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19C - LAKES ST. CLAIR & ERIE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	11	11	11	11	11
1991	14	14	16	13	15
2001	18	15	21	16	20
2011	23	17	30	18	25

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19C - LAKES ST. CLAIR & ERIE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	272	272	272	272	272
1991	329	288	339	307	348
2001	385	283	417	336	439
2011	454	263	530	362	531

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19C - LAKES ST. CLAIR & ERIE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	272	272	272	272	272
1991	329	288	339	307	348
2001	385	283	417	336	439
2011	454	263	530	362	531

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19C - LAKES ST. CLAIR & ERIE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	41	41	41	41	41
1991	49	48	51	46	52
2001	58	43	63	50	66
2011	68	39	80	54	80

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19D - LAKE ONTARIO & UPPER ST. LAWRENCE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	42	42	42	42	42
Mineral	1	1	1	1	1
Manufact	1288	1288	1288	1288	1288
Power	4730	4730	4730	4730	4730
Municipal	885	885	885	885	885
Total	6946	6946	6946	6946	6946
1991					
Agricul	52	44	49	49	56
Mineral	2	2	3	1	2
Manufact	1613	1365	1630	1489	1750
Power	5912	5450	6611	5501	6307
Municipal	1067	934	1101	999	1131
Total	8645	7795	9393	8039	9245
2001					
Agricul	63	42	58	54	73
Mineral	2	2	6	2	2
Manufact	2109	1420	2159	1786	2472
Power	7526	6284	9061	6687	8401
Municipal	1251	921	1355	1092	1426
Total	10951	8669	12639	9621	12374
2011					
Agricul	76	36	71	60	90
Mineral	3	2	11	2	3
Manufact	2769	1322	2912	2036	3224
Power	9602	7082	12531	7761	10567
Municipal	1474	855	1723	1177	1727
Total	13924	9296	17249	11036	15611

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011,
BASIN 19D - LAKE ONTARIO & UPPER ST. LAWRENCE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	42	42	42	42	42
Mineral	2	2	2	2	2
Manufact	2525	2525	2525	2525	2525
Power	4730	4730	4730	4730	4730
Municipal	885	885	885	885	885
Total	8184	8184	8184	8184	8184
1991					
Agricul	52	44	49	49	56
Mineral	2	2	5	2	3
Manufact	3157	2686	3231	2924	3421
Power	5912	5450	6611	5501	6307
Municipal	1067	934	1101	999	1131
Total	10190	9117	10996	9474	10917
2001					
Agricul	63	42	58	54	73
Mineral	3	3	9	3	4
Manufact	4088	2793	4284	3464	4799
Power	7526	6284	9061	6687	8401
Municipal	1251	921	1355	1092	1426
Total	12931	10043	14767	11300	14702
2011					
Agricul	76	36	71	60	90
Mineral	4	3	18	3	5
Manufact	5315	2623	5790	3922	6226
Power	9602	7082	12531	7761	10567
Municipal	1474	855	1723	1177	1727
Total	16471	10598	20132	12923	18615

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19D - LAKE ONTARIO & UPPER ST. LAWRENCE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	35	35	35	35	35
Mineral	0	0	0	0	0
Manufact	51	51	51	51	51
Power	11	11	11	11	11
Municipal	133	133	133	133	133
Total	231	231	231	231	231
1991					
Agricul	44	43	41	41	46
Mineral	0	0	0	0	0
Manufact	63	62	65	59	69
Power	14	14	16	13	15
Municipal	160	156	165	150	170
Total	282	275	288	263	300
2001					
Agricul	52	35	48	45	60
Mineral	0	0	1	0	0
Manufact	81	57	84	69	95
Power	18	15	22	16	20
Municipal	188	138	203	164	214
Total	339	245	359	294	390
2011					
Agricul	63	30	59	50	75
Mineral	0	0	2	0	0
Manufact	103	54	111	77	122
Power	23	17	30	19	26
Municipal	221	128	259	177	259
Total	410	229	461	322	481

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19D - LAKE ONTARIO & UPPER ST. LAWRENCE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	42	42	42	42	42
1991	52	44	49	49	56
2001	63	42	58	54	73
2011	76	36	71	60	90

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19D - LAKE ONTARIO & UPPER ST. LAWRENCE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	42	42	42	42	42
1991	52	44	49	49	56
2001	63	42	58	54	73
2011	76	36	71	60	90

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19D - LAKE ONTARIO & UPPER ST. LAWRENCE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	35	35	35	35	35
1991	44	43	41	41	46
2001	52	35	48	45	60
2011	63	30	59	50	75

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19D - LAKE ONTARIO & UPPER ST. LAWRENCE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	2	2	3	1	2
2001	2	2	6	2	2
2011	3	2	11	2	3

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-20
BASIN 19D - LAKE ONTARIO & UPPER ST. LAWRENCE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2	2	2	2	2
1991	2	2	5	2	3
2001	3	3	9	3	4
2011	4	3	18	3	5

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-20
BASIN 19D - LAKE ONTARIO & UPPER ST. LAWRENCE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	1	0	0
2011	0	0	2	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19D - LAKE ONTARIO & UPPER ST. LAWRENCE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1288	1288	1288	1288	1288
1991	1613	1365	1630	1489	1750
2001	2109	1420	2159	1786	2472
2011	2769	1322	2912	2036	3224

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19D - LAKE ONTARIO & UPPER ST. LAWRENCE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2525	2525	2525	2525	2525
1991	3157	2686	3231	2924	3421
2001	4088	2793	4284	3464	4799
2011	5315	2623	5790	3922	6226

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19D - LAKE ONTARIO & UPPER ST. LAWRENCE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	51	51	51	51	51
1991	63	62	65	59	69
2001	81	57	84	69	95
2011	103	54	111	77	122

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19D - LAKE ONTARIO & UPPER ST. LAWRENCE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4730	4730	4730	4730	4730
1991	5912	5450	6611	5501	6307
2001	7526	6284	9061	6687	8401
2011	9602	7082	12531	7761	10567

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19D - LAKE ONTARIO & UPPER ST. LAWRENCE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4730	4730	4730	4730	4730
1991	5912	5450	6611	5501	6307
2001	7526	6284	9061	6687	8401
2011	9602	7082	12531	7761	10567

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19D - LAKE ONTARIO & UPPER ST. LAWRENCE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	11	11	11	11	11
1991	14	14	16	13	15
2001	18	15	22	16	20
2011	23	17	30	19	26

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 19D - LAKE ONTARIO & UPPER ST. LAWRENCE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	885	885	885	885	885
1991	1067	934	1101	999	1131
2001	1251	921	1355	1092	1426
2011	1474	855	1723	1177	1727

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19D - LAKE ONTARIO & UPPER ST. LAWRENCE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	885	885	885	885	885
1991	1067	934	1101	999	1131
2001	1251	921	1355	1092	1426
2011	1474	855	1723	1177	1727

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 19D - LAKE ONTARIO & UPPER ST. LAWRENCE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	133	133	133	133	133
1991	160	156	165	150	170
2001	188	138	203	164	214
2011	221	128	259	177	259

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	18	18	18	18	18
Mineral	25	25	25	25	25
Manufact	82	82	82	82	82
Power	0	0	0	0	0
Municipal	125	125	125	125	125
Total	250	250	250	250	250
1991					
Agricul	22	19	21	21	24
Mineral	33	31	29	30	37
Manufact	100	84	97	96	105
Power	0	0	0	0	0
Municipal	151	132	155	141	160
Total	306	266	302	288	325
2001					
Agricul	27	18	25	23	31
Mineral	44	37	35	38	52
Manufact	122	82	117	109	138
Power	0	0	0	0	0
Municipal	176	130	191	154	201
Total	370	267	369	324	422
2011					
Agricul	32	15	30	26	38
Mineral	59	44	44	45	68
Manufact	150	72	143	120	170
Power	0	0	0	0	0
Municipal	208	121	244	166	243
Total	449	252	460	357	520

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011, BASIN 20 - OTTAWA RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	18	18	18	18	18
Mineral	73	73	73	73	73
Manufact	313	313	313	313	313
Power	0	0	0	0	0
Municipal	125	125	125	125	125
Total	529	529	529	529	529
1991					
Agricul	22	19	21	21	24
Mineral	99	91	85	89	110
Manufact	378	320	368	365	398
Power	0	0	0	0	0
Municipal	151	132	155	141	160
Total	650	562	630	616	691
2001					
Agricul	27	18	25	23	31
Mineral	132	110	104	112	155
Manufact	464	312	445	414	522
Power	0	0	0	0	0
Municipal	176	130	191	154	201
Total	799	570	766	703	909
2011					
Agricul	32	15	30	26	38
Mineral	176	130	129	134	202
Manufact	569	272	540	455	645
Power	0	0	0	0	0
Municipal	208	121	244	166	243
Total	985	538	943	780	1129

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	15	15	15	15	15
Mineral	0	0	0	0	0
Manufact	2	2	2	2	2
Power	0	0	0	0	0
Municipal	19	19	19	19	19
Total	36	36	36	36	36
1991					
Agricul	19	19	17	17	20
Mineral	0	0	0	0	0
Manufact	2	2	2	2	2
Power	0	0	0	0	0
Municipal	23	22	23	21	24
Total	43	43	43	41	46
2001					
Agricul	22	15	21	19	26
Mineral	0	0	0	0	0
Manufact	3	2	3	2	3
Power	0	0	0	0	0
Municipal	26	19	29	23	30
Total	51	36	52	45	59
2011					
Agricul	27	13	25	21	32
Mineral	0	0	0	0	0
Manufact	3	2	3	3	4
Power	0	0	0	0	0
Municipal	31	18	37	25	36
Total	61	33	65	49	72

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	18	18	18	18	18
1991	22	19	21	21	24
2001	27	18	25	23	31
2011	32	15	30	26	38

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	18	18	18	18	18
1991	22	19	21	21	24
2001	27	18	25	23	31
2011	32	15	30	26	38

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	15	15	15	15	15
1991	19	19	17	17	20
2001	22	15	21	19	26
2011	27	13	25	21	32

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	25	25	25	25	25
1991	33	31	29	30	37
2001	44	37	35	38	52
2011	59	44	44	45	68

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-20
BASIN 20 - OTTAWA RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	73	73	73	73	73
1991	99	91	85	89	110
2001	132	110	104	112	155
2011	176	130	129	134	202

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-20
BASIN 20 - OTTAWA RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	82	82	82	82	82
1991	100	84	97	96	105
2001	122	82	117	109	138
2011	150	72	143	120	170

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	313	313	313	313	313
1991	378	320	368	365	398
2001	464	312	445	414	522
2011	569	272	540	455	645

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2	2	2	2	2
1991	2	2	2	2	2
2001	3	2	3	2	3
2011	3	2	3	3	4

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	125	125	125	125	125
1991	151	132	155	141	160
2001	176	130	191	154	201
2011	208	121	244	166	243

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	125	125	125	125	125
1991	151	132	155	141	160
2001	176	130	191	154	201
2011	208	121	244	166	243

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN ONTARIO REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	19	19	19	19	19
1991	23	22	23	21	24
2001	26	19	29	23	30
2011	31	18	37	25	36

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
QUEBEC REGION (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	82	82	82	82	82
Mineral	107	107	107	107	107
Manufact	2386	2386	2386	2386	2386
Power	308	308	308	308	308
Municipal	1369	1369	1369	1369	1369
Total	4252	4252	4252	4252	4252
1991					
Agricul	96	81	96	96	106
Mineral	138	128	122	129	153
Manufact	2967	2554	3037	2817	3134
Power	393	362	454	369	419
Municipal	1597	1398	1650	1514	1702
Total	5192	4523	5360	4925	5514
2001					
Agricul	115	77	115	106	137
Mineral	186	155	155	169	215
Manufact	3691	2605	3853	3201	4232
Power	487	407	611	439	542
Municipal	1797	1323	1933	1594	2059
Total	6276	4567	6666	5510	7184
2011					
Agricul	138	65	138	115	168
Mineral	250	184	202	208	277
Manufact	4602	2451	4937	3535	5370
Power	605	446	829	502	666
Municipal	2035	1180	2336	1667	2420
Total	7629	4327	8441	6029	8901

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011, QUEBEC REGION (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	82	82	82	82	82
Mineral	333	333	333	333	333
Manufact	5255	5255	5255	5255	5255
Power	308	308	308	308	308
Municipal	1369	1369	1369	1369	1369
Total	7346	7346	7346	7346	7346
1991					
Agricul	96	81	96	96	106
Mineral	432	398	379	404	479
Manufact	6540	5598	6632	6202	6881
Power	393	362	454	369	419
Municipal	1597	1398	1650	1514	1702
Total	9058	7838	9212	8584	9587
2001					
Agricul	115	77	115	106	137
Mineral	579	484	482	529	670
Manufact	8096	5634	8327	7027	9246
Power	487	407	611	439	542
Municipal	1797	1323	1933	1594	2059
Total	11075	7924	11468	9696	12654
2011					
Agricul	138	65	138	115	168
Mineral	779	574	627	650	863
Manufact	10045	5195	10578	7744	11715
Power	605	446	829	502	666
Municipal	2035	1180	2336	1667	2420
Total	13601	7460	14507	10680	15832

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR, 1981-2011
QUEBEC REGION (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	81	81	81	81	81
Mineral	10	10	10	10	10
Manufact	135	135	135	135	135
Power	4	4	4	4	4
Municipal	205	205	205	205	205
Total	435	435	435	435	435
1991					
Agricul	95	80	95	94	104
Mineral	13	12	12	13	15
Manufact	169	145	174	160	178
Power	5	5	6	5	6
Municipal	212	186	225	204	222
Total	494	428	512	475	525
2001					
Agricul	113	76	113	104	134
Mineral	18	15	15	16	21
Manufact	209	148	221	180	239
Power	6	5	8	6	7
Municipal	236	174	267	216	260
Total	582	417	624	523	661
2011					
Agricul	135	64	135	113	165
Mineral	24	18	19	20	27
Manufact	259	139	285	198	306
Power	8	6	11	7	9
Municipal	264	153	331	228	298
Total	690	380	782	566	804

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	82	82	82	82	82
1991	96	81	96	96	106
2001	115	77	115	106	137
2011	138	65	138	115	168

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	82	82	82	82	82
1991	96	81	96	96	106
2001	115	77	115	106	137
2011	138	65	138	115	168

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	81	81	81	81	81
1991	95	80	95	94	104
2001	113	76	113	104	134
2011	135	64	135	113	165

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	107	107	107	107	107
1991	138	128	122	129	153
2001	186	155	155	169	215
2011	250	184	202	208	277

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-20
QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	333	333	333	333	333
1991	432	398	379	404	479
2001	579	484	482	529	670
2011	779	574	627	650	863

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-20
QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	10	10	10	10	10
1991	13	12	12	13	15
2001	18	15	15	16	21
2011	24	18	19	20	27

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2386	2386	2386	2386	2386
1991	2967	2554	3037	2817	3134
2001	3691	2605	3853	3201	4232
2011	4602	2451	4937	3535	5370

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	5255	5255	5255	5255	5255
1991	6540	5598	6632	6202	6881
2001	8096	5634	8327	7027	9246
2011	10045	5195	10578	7744	11715

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	135	135	135	135	135
1991	169	145	174	160	178
2001	209	148	221	180	239
2011	259	139	285	198	306

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	308	308	308	308	308
1991	393	362	454	369	419
2001	487	407	611	439	542
2011	605	446	829	502	666

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	308	308	308	308	308
1991	393	362	454	369	419
2001	487	407	611	439	542
2011	605	446	829	502	666

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4	4	4	4	4
1991	5	5	6	5	6
2001	6	5	8	6	7
2011	8	6	11	7	9

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1369	1369	1369	1369	1369
1991	1597	1398	1650	1514	1702
2001	1797	1323	1933	1594	2059
2011	2035	1180	2336	1667	2420

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1369	1369	1369	1369	1369
1991	1597	1398	1650	1514	1702
2001	1797	1323	1933	1594	2059
2011	2035	1180	2336	1667	2420

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	205	205	205	205	205
1991	212	186	225	204	222
2001	236	174	267	216	260
2011	264	153	331	228	298

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 18 - NORTHERN QUEBEC (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	46	46	46	46	46
Manufact	74	74	74	74	74
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	120	120	120	120	120
1991					
Agricul	0	0	0	0	0
Mineral	60	55	53	56	66
Manufact	90	76	89	87	93
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	150	131	141	143	159
2001					
Agricul	0	0	0	0	0
Mineral	80	67	67	73	93
Manufact	110	73	107	97	121
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	190	141	174	170	213
2011					
Agricul	0	0	0	0	0
Mineral	108	80	87	90	120
Manufact	133	63	129	105	148
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	241	143	216	195	268

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011,
BASIN 18 - NORTHERN QUEBEC (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	80	80	80	80	80
Manufact	81	81	81	81	81
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	161	161	161	161	161
1991					
Agricul	0	0	0	0	0
Mineral	103	95	91	97	115
Manufact	99	83	97	96	102
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	202	179	188	192	216
2001					
Agricul	0	0	0	0	0
Mineral	139	116	115	127	160
Manufact	120	81	117	106	132
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	259	196	232	233	293
2011					
Agricul	0	0	0	0	0
Mineral	186	137	149	156	206
Manufact	146	70	142	115	162
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	333	207	291	271	369

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 18 - NORTHERN QUEBEC (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	9	9	9	9	9
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	9	9	9	9	9
1991					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	11	9	11	10	11
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	11	9	11	10	11
2001					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	13	9	13	12	14
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	13	9	13	12	14
2011					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	16	8	15	13	18
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	16	8	15	13	18

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 18 - NORTHERN QUEBEC (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 18 - NORTHERN QUEBEC (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 18 - NORTHERN QUEBEC (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 18 - NORTHERN QUEBEC (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	46	46	46	46	46
1991	60	55	53	56	66
2001	80	67	67	73	93
2011	108	80	87	90	120

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-20
BASIN 18 - NORTHERN QUEBEC (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	80	80	80	80	80
1991	103	95	91	97	115
2001	139	116	115	127	160
2011	186	137	149	156	206

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-20
BASIN 18 - NORTHERN QUEBEC (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 18 - NORTHERN QUEBEC (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	74	74	74	74	74
1991	90	76	89	87	93
2001	110	73	107	97	121
2011	133	63	129	105	148

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 18 - NORTHERN QUEBEC (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	81	81	81	81	81
1991	99	83	97	96	102
2001	120	81	117	106	132
2011	146	70	142	115	162

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 18 - NORTHERN QUEBEC (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	9	9	9	9	9
1991	11	9	11	10	11
2001	13	9	13	12	14
2011	16	8	15	13	18

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 18 - NORTHERN QUEBEC (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 18 - NORTHERN QUEBEC (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 18 - NORTHERN QUEBEC (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 18 - NORTHERN QUEBEC (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 18 - NORTHERN QUEBEC (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 18 - NORTHERN QUEBEC (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN QUEBEC REGION (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	10	10	10	10	10
Mineral	36	36	36	36	36
Manufact	270	270	270	270	270
Power	0	0	0	0	0
Municipal	57	57	57	57	57
Total	373	373	373	373	373
1991					
Agricul	11	9	11	11	12
Mineral	46	43	41	43	52
Manufact	333	284	334	319	346
Power	0	0	0	0	0
Municipal	66	58	69	63	70
Total	457	394	455	437	480
2001					
Agricul	13	9	13	12	16
Mineral	62	52	52	57	72
Manufact	410	282	415	359	460
Power	0	0	0	0	0
Municipal	74	55	81	67	84
Total	560	398	562	495	632
2011					
Agricul	16	8	16	13	19
Mineral	84	62	67	70	93
Manufact	507	256	519	394	574
Power	0	0	0	0	0
Municipal	84	49	99	70	98
Total	690	374	702	547	784

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011,
BASIN 20 - OTTAWA RIVER IN QUEBEC REGION (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	10	10	10	10	10
Mineral	45	45	45	45	45
Manufact	567	567	567	567	567
Power	0	0	0	0	0
Municipal	57	57	57	57	57
Total	679	679	679	679	679
1991					
Agricul	11	9	11	11	12
Mineral	58	54	51	55	65
Manufact	695	590	690	670	719
Power	0	0	0	0	0
Municipal	66	58	69	63	70
Total	831	711	822	798	866
2001					
Agricul	13	9	13	12	16
Mineral	78	65	65	71	91
Manufact	852	578	845	750	945
Power	0	0	0	0	0
Municipal	74	55	81	67	84
Total	1017	707	1005	900	1135
2011					
Agricul	16	8	16	13	19
Mineral	105	78	85	88	117
Manufact	1044	510	1039	818	1170
Power	0	0	0	0	0
Municipal	84	49	99	70	98
Total	1249	644	1239	989	1404

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 20 - OTTAWA RIVER IN QUEBEC REGION (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	9	9	9	9	9
Mineral	0	0	0	0	0
Manufact	23	23	23	23	23
Power	0	0	0	0	0
Municipal	9	9	9	9	9
Total	41	41	41	41	41
1991					
Agricul	11	9	11	11	12
Mineral	0	0	0	0	0
Manufact	29	24	29	27	30
Power	0	0	0	0	0
Municipal	10	9	11	10	11
Total	50	42	50	48	52
2001					
Agricul	13	9	13	12	16
Mineral	0	0	0	0	0
Manufact	36	24	36	32	39
Power	0	0	0	0	0
Municipal	11	8	13	10	12
Total	60	41	62	55	67
2011					
Agricul	16	7	16	13	19
Mineral	0	0	0	0	0
Manufact	44	20	45	36	48
Power	0	0	0	0	0
Municipal	13	7	16	11	14
Total	73	35	77	61	82

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	10	10	10	10	10
1991	11	9	11	11	12
2001	13	9	13	12	16
2011	16	8	16	13	19

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	10	10	10	10	10
1991	11	9	11	11	12
2001	13	9	13	12	16
2011	16	8	16	13	19

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	9	9	9	9	9
1991	11	9	11	11	12
2001	13	9	13	12	16
2011	16	7	16	13	19

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	36	36	36	36	36
1991	46	43	41	43	52
2001	62	52	52	57	72
2011	84	62	67	70	93

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-20
BASIN 20 - OTTAWA RIVER IN QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	45	45	45	45	45
1991	58	54	51	55	65
2001	78	65	65	71	91
2011	105	78	85	88	117

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-20
BASIN 20 - OTTAWA RIVER IN QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	270	270	270	270	270
1991	333	284	334	319	346
2001	410	282	415	359	460
2011	507	256	519	394	574

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	567	567	567	567	567
1991	695	590	690	670	719
2001	852	578	845	750	945
2011	1044	510	1039	818	1170

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	23	23	23	23	23
1991	29	24	29	27	30
2001	36	24	36	32	39
2011	44	20	45	36	48

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	57	57	57	57	57
1991	66	58	69	63	70
2001	74	55	81	67	84
2011	84	49	99	70	98

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	57	57	57	57	57
1991	66	58	69	63	70
2001	74	55	81	67	84
2011	84	49	99	70	98

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 20 - OTTAWA RIVER IN QUEBEC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	9	9	9	9	9
1991	10	9	11	10	11
2001	11	8	13	10	12
2011	13	7	16	11	14

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 21 - ST. LAWRENCE RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	65	65	65	65	65
Mineral	3	3	3	3	3
Manufact	1674	1674	1674	1674	1674
Power	308	308	308	308	308
Municipal	1207	1207	1207	1207	1207
Total	3257	3257	3257	3257	3257
1991					
Agricul	76	64	76	76	84
Mineral	3	3	3	3	4
Manufact	2087	1806	2161	1975	2218
Power	393	362	454	369	419
Municipal	1409	1233	1455	1335	1501
Total	3969	3469	4150	3758	4227
2001					
Agricul	91	61	91	84	108
Mineral	5	4	5	4	6
Manufact	2596	1858	2760	2237	3006
Power	487	407	611	439	542
Municipal	1585	1167	1704	1406	1816
Total	4764	3496	5171	4171	5479
2011					
Agricul	109	52	109	91	132
Mineral	7	5	7	5	8
Manufact	3234	1773	3564	2466	3832
Power	605	446	829	502	666
Municipal	1795	1041	2060	1471	2136
Total	5750	3317	6568	4535	6774

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 21 - ST. LAWRENCE RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	65	65	65	65	65
Mineral	4	4	4	4	4
Manufact	3498	3498	3498	3498	3498
Power	308	308	308	308	308
Municipal	1207	1207	1207	1207	1207
Total	5083	5083	5083	5083	5083
1991					
Agricul	76	64	76	76	84
Mineral	6	5	6	5	7
Manufact	4376	3757	4491	4127	4655
Power	393	362	454	369	419
Municipal	1409	1233	1455	1335	1501
Total	6260	5422	6483	5912	6666
2001					
Agricul	91	61	91	84	108
Mineral	8	7	8	7	10
Manufact	5415	3796	5681	4675	6272
Power	487	407	611	439	542
Municipal	1585	1167	1704	1406	1816
Total	7586	5437	8096	6612	8749
2011					
Agricul	109	52	109	91	132
Mineral	11	8	11	9	13
Manufact	6711	3523	7286	5153	7988
Power	605	446	829	502	666
Municipal	1795	1041	2060	1471	2136
Total	9231	5070	10294	7226	10936

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 21 - ST. LAWRENCE RIVER (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	64	64	64	64	64
Mineral	0	0	0	0	0
Manufact	94	94	94	94	94
Power	4	4	4	4	4
Municipal	181	181	181	181	181
Total	343	343	343	343	343
1991					
Agricul	75	63	75	75	82
Mineral	0	0	0	0	0
Manufact	118	102	123	110	126
Power	5	5	6	5	6
Municipal	187	163	198	179	196
Total	384	334	402	369	409
2001					
Agricul	89	60	89	83	106
Mineral	0	0	0	0	0
Manufact	145	105	158	124	170
Power	6	5	8	6	7
Municipal	207	153	235	190	228
Total	449	323	490	402	512
2011					
Agricul	107	51	107	90	130
Mineral	0	0	0	0	0
Manufact	180	101	206	135	220
Power	8	6	11	7	9
Municipal	232	135	291	200	262
Total	527	292	615	432	621

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 21 - ST. LAWRENCE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	65	65	65	65	65
1991	76	64	76	76	84
2001	91	61	91	84	108
2011	109	52	109	91	132

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 21 - ST. LAWRENCE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	65	65	65	65	65
1991	76	64	76	76	84
2001	91	61	91	84	108
2011	109	52	109	91	132

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 21 - ST. LAWRENCE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	64	64	64	64	64
1991	75	63	75	75	82
2001	89	60	89	83	106
2011	107	51	107	90	130

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 21 - ST. LAWRENCE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3	3	3	3	3
1991	3	3	3	3	4
2001	5	4	5	4	6
2011	7	5	7	5	8

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-201
BASIN 21 - ST. LAWRENCE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4	4	4	4	4
1991	6	5	6	5	7
2001	8	7	8	7	10
2011	11	8	11	9	13

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-201
BASIN 21 - ST. LAWRENCE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 21 - ST. LAWRENCE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1674	1674	1674	1674	1674
1991	2087	1806	2161	1975	2218
2001	2596	1858	2760	2237	3006
2011	3234	1773	3564	2466	3832

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 21 - ST. LAWRENCE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3498	3498	3498	3498	3498
1991	4376	3757	4491	4127	4655
2001	5415	3796	5681	4675	6272
2011	6711	3523	7286	5153	7988

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 21 - ST. LAWRENCE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	94	94	94	94	94
1991	118	102	123	110	126
2001	145	105	158	124	170
2011	180	101	206	135	220

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 21 - ST. LAWRENCE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	308	308	308	308	308
1991	393	362	454	369	419
2001	487	407	611	439	542
2011	605	446	829	502	666

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 21 - ST. LAWRENCE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	308	308	308	308	308
1991	393	362	454	369	419
2001	487	407	611	439	542
2011	605	446	829	502	666

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 21 - ST. LAWRENCE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4	4	4	4	4
1991	5	5	6	5	6
2001	6	5	8	6	7
2011	8	6	11	7	9

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 21 - ST. LAWRENCE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1207	1207	1207	1207	1207
1991	1409	1233	1455	1335	1501
2001	1585	1167	1704	1406	1816
2011	1795	1041	2060	1471	2136

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 21 - ST. LAWRENCE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1207	1207	1207	1207	1207
1991	1409	1233	1455	1335	1501
2001	1585	1167	1704	1406	1816
2011	1795	1041	2060	1471	2136

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 21 - ST. LAWRENCE RIVER (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	181	181	181	181	181
1991	187	163	198	179	196
2001	207	153	235	190	228
2011	232	135	291	200	262

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 22 - NORTH SHORE & GASPE (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	8	8	8	8	8
Mineral	22	22	22	22	22
Manufact	301	301	301	301	301
Power	0	0	0	0	0
Municipal	104	104	104	104	104
Total	435	435	435	435	435
1991					
Agricul	9	8	9	9	10
Mineral	28	26	25	27	31
Manufact	369	310	365	356	382
Power	0	0	0	0	0
Municipal	122	107	126	116	130
Total	529	451	525	507	554
2001					
Agricul	11	7	11	10	13
Mineral	38	32	32	35	44
Manufact	455	302	448	409	500
Power	0	0	0	0	0
Municipal	137	101	147	122	158
Total	642	442	637	575	715
2011					
Agricul	13	6	13	11	16
Mineral	51	38	41	43	57
Manufact	562	260	553	455	617
Power	0	0	0	0	0
Municipal	156	90	177	127	186
Total	782	394	784	636	876

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011, BASIN 22 - NORTH SHORE & GASPE (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	8	8	8	8	8
Mineral	204	204	204	204	204
Manufact	913	913	913	913	913
Power	0	0	0	0	0
Municipal	104	104	104	104	104
Total	1229	1229	1229	1229	1229
1991					
Agricul	9	8	9	9	10
Mineral	264	244	232	247	293
Manufact	1117	941	1098	1079	1150
Power	0	0	0	0	0
Municipal	122	107	126	116	130
Total	1512	1299	1464	1451	1583
2001					
Agricul	11	7	11	10	13
Mineral	354	296	294	324	409
Manufact	1363	911	1331	1211	1500
Power	0	0	0	0	0
Municipal	137	101	147	122	158
Total	1866	1315	1783	1666	2080
2011					
Agricul	13	6	13	11	16
Mineral	476	351	382	398	527
Manufact	1667	785	1619	1323	1844
Power	0	0	0	0	0
Municipal	156	90	177	127	186
Total	2311	1233	2191	1859	2573

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 22 - NORTH SHORE & GASPE (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	8	8	8	8	8
Mineral	10	10	10	10	10
Manufact	6	6	6	6	6
Power	0	0	0	0	0
Municipal	16	16	16	16	16
Total	39	39	39	39	39
1991					
Agricul	9	7	9	9	10
Mineral	13	12	12	13	15
Manufact	7	6	7	7	7
Power	0	0	0	0	0
Municipal	15	13	16	15	16
Total	45	39	44	43	48
2001					
Agricul	11	7	11	10	12
Mineral	18	15	15	16	21
Manufact	9	6	9	8	10
Power	0	0	0	0	0
Municipal	17	13	19	16	19
Total	54	40	53	50	62
2011					
Agricul	13	6	13	11	15
Mineral	24	18	19	20	27
Manufact	11	5	10	8	12
Power	0	0	0	0	0
Municipal	19	11	24	16	22
Total	66	40	66	56	75

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 22 - NORTH SHORE & GASPE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	8	8	8	8	8
1991	9	8	9	9	10
2001	11	7	11	10	13
2011	13	6	13	11	16

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 22 - NORTH SHORE & GASPE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	8	8	8	8	8
1991	9	8	9	9	10
2001	11	7	11	10	13
2011	13	6	13	11	16

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 22 - NORTH SHORE & GASPE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	8	8	8	8	8
1991	9	7	9	9	10
2001	11	7	11	10	12
2011	13	6	13	11	15

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 22 - NORTH SHORE & GASPE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	22	22	22	22	22
1991	28	26	25	27	31
2001	38	32	32	35	44
2011	51	38	41	43	57

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-201
BASIN 22 - NORTH SHORE & GASPE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	204	204	204	204	204
1991	264	244	232	247	293
2001	354	296	294	324	409
2011	476	351	382	398	527

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-201
BASIN 22 - NORTH SHORE & GASPE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	10	10	10	10	10
1991	13	12	12	13	15
2001	18	15	15	16	21
2011	24	18	19	20	27

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 22 - NORTH SHORE & GASPE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	301	301	301	301	301
1991	369	310	365	356	382
2001	455	302	448	409	500
2011	562	260	553	455	617

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 22 - NORTH SHORE & GASPE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	913	913	913	913	913
1991	1117	941	1098	1079	1150
2001	1363	911	1331	1211	1500
2011	1667	785	1619	1323	1844

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 22 - NORTH SHORE & GASPE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	6	6	6	6	6
1991	7	6	7	7	7
2001	9	6	9	8	10
2011	11	5	10	8	12

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 22 - NORTH SHORE & GASPE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 22 - NORTH SHORE & GASPE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 22 - NORTH SHORE & GASPE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 22 - NORTH SHORE & GASPE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	104	104	104	104	104
1991	122	107	126	116	130
2001	137	101	147	122	158
2011	156	90	177	127	186

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 22 - NORTH SHORE & GASPE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	104	104	104	104	104
1991	122	107	126	116	130
2001	137	101	147	122	158
2011	156	90	177	127	186

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 22 - NORTH SHORE & GASPE (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	16	16	16	16	16
1991	15	13	16	15	16
2001	17	13	19	16	19
2011	19	11	24	16	22

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
ATLANTIC REGION (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	12	12	12	12	12
Mineral	85	85	85	85	85
Manufact	643	643	643	643	643
Power	1837	1837	1837	1837	1837
Municipal	307	307	307	307	307
Total	2884	2884	2884	2884	2884
1991					
Agricul	14	12	14	13	16
Mineral	114	105	114	97	133
Manufact	759	644	777	741	783
Power	2319	2138	2565	2160	2473
Municipal	369	323	383	350	390
Total	3575	3222	3853	3362	3795
2001					
Agricul	17	11	17	15	20
Mineral	157	131	156	147	162
Manufact	925	629	969	835	1024
Power	2951	2464	3476	2677	3250
Municipal	399	294	434	357	445
Total	4449	3529	5052	4030	4902
2011					
Agricul	20	9	20	16	24
Mineral	218	161	216	202	191
Manufact	1133	555	1229	923	1285
Power	3778	2787	4768	3072	3937
Municipal	435	252	517	366	492
Total	5584	3764	6749	4579	5929

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011, ATLANTIC REGION (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	12	12	12	12	12
Mineral	648	648	648	648	648
Manufact	1045	1045	1045	1045	1045
Power	1837	1837	1837	1837	1837
Municipal	307	307	307	307	307
Total	3849	3849	3849	3849	3849
1991					
Agricul	14	12	14	13	16
Mineral	837	771	832	711	974
Manufact	1240	1054	1276	1200	1287
Power	2319	2138	2565	2160	2473
Municipal	369	323	383	350	390
Total	4778	4298	5070	4435	5139
2001					
Agricul	17	11	17	15	20
Mineral	1173	980	1163	1102	1194
Manufact	1510	1031	1604	1344	1691
Power	2951	2464	3476	2677	3250
Municipal	399	294	434	357	445
Total	6050	4780	6695	5494	6601
2011					
Agricul	20	9	20	16	24
Mineral	1647	1215	1631	1525	1411
Manufact	1848	915	2060	1480	2136
Power	3778	2787	4768	3072	3937
Municipal	435	252	517	366	492
Total	7728	5178	8995	6459	8001

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR, 1981-2011
ATLANTIC REGION (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	12	12	12	12	12
Mineral	8	8	8	8	8
Manufact	33	33	33	33	33
Power	41	41	41	41	41
Municipal	46	46	46	46	46
Total	139	139	139	139	139
1991					
Agricul	14	12	14	13	16
Mineral	11	10	11	9	12
Manufact	38	32	38	37	38
Power	51	47	57	48	55
Municipal	55	48	58	52	58
Total	169	150	177	160	179
2001					
Agricul	17	11	17	15	20
Mineral	15	12	15	14	15
Manufact	45	31	47	42	49
Power	65	55	77	59	72
Municipal	67	44	65	53	67
Total	209	153	220	183	223
2011					
Agricul	20	9	20	16	24
Mineral	21	15	20	19	18
Manufact	54	26	57	45	61
Power	84	62	106	68	87
Municipal	65	38	78	55	74
Total	244	151	281	203	263

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
ATLANTIC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	12	12	12	12	12
1991	14	12	14	13	16
2001	17	11	17	15	20
2011	20	9	20	16	24

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
ATLANTIC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	12	12	12	12	12
1991	14	12	14	13	16
2001	17	11	17	15	20
2011	20	9	20	16	24

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
ATLANTIC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	12	12	12	12	12
1991	14	12	14	13	16
2001	17	11	17	15	20
2011	20	9	20	16	24

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
ATLANTIC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	85	85	85	85	85
1991	114	105	114	97	133
2001	157	131	156	147	162
2011	218	161	216	202	191

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-201
ATLANTIC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	648	648	648	648	648
1991	837	771	832	711	974
2001	1173	980	1163	1102	1194
2011	1647	1215	1631	1525	1411

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-201
ATLANTIC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	8	8	8	8	8
1991	11	10	11	9	12
2001	15	12	15	14	15
2011	21	15	20	19	18

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
ATLANTIC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	643	643	643	643	643
1991	759	644	777	741	783
2001	925	629	969	835	1024
2011	1133	555	1229	923	1285

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
ATLANTIC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1045	1045	1045	1045	1045
1991	1240	1054	1276	1200	1287
2001	1510	1031	1604	1344	1691
2011	1848	915	2060	1480	2136

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
ATLANTIC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	33	33	33	33	33
1991	38	32	38	37	38
2001	45	31	47	42	49
2011	54	26	57	45	61

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
ATLANTIC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1837	1837	1837	1837	1837
1991	2319	2138	2565	2160	2473
2001	2951	2464	3476	2677	3250
2011	3778	2787	4768	3072	3937

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
ATLANTIC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1837	1837	1837	1837	1837
1991	2319	2138	2565	2160	2473
2001	2951	2464	3476	2677	3250
2011	3778	2787	4768	3072	3937

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
ATLANTIC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	41	41	41	41	41
1991	51	47	57	48	55
2001	65	55	77	59	72
2011	84	62	106	68	87

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
ATLANTIC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	307	307	307	307	307
1991	369	323	383	350	390
2001	399	280	434	357	445
2011	435	252	517	366	492

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
ATLANTIC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	307	307	307	307	307
1991	369	323	383	350	390
2001	399	294	434	357	445
2011	435	252	517	366	492

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
ATLANTIC REGION (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	46	46	46	46	46
1991	55	48	58	52	58
2001	60	44	65	53	67
2011	65	38	78	55	74

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 23 - ST. JOHN & ST. CROIX (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	2	2	2	2	2
Mineral	0	0	0	0	0
Manufact	133	133	133	133	133
Power	635	635	635	635	635
Municipal	111	111	111	111	111
Total	882	882	882	882	882
1991					
Agricul	2	2	2	2	2
Mineral	0	0	0	0	0
Manufact	149	127	152	151	148
Power	802	740	887	747	856
Municipal	136	119	141	128	145
Total	1090	987	1182	1029	1151
2001					
Agricul	3	2	3	2	3
Mineral	0	0	0	0	0
Manufact	179	121	186	168	190
Power	1021	853	1203	926	1124
Municipal	148	109	159	130	167
Total	1351	1085	1550	1227	1485
2011					
Agricul	3	1	3	2	4
Mineral	0	0	0	0	0
Manufact	215	105	230	182	235
Power	1307	964	1649	1063	1362
Municipal	161	94	188	133	185
Total	1687	1164	2071	1381	1786

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR,1981-2011,
BASIN 23 - ST. JOHN & ST. CROIX (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	2	2	2	2	2
Mineral	0	0	0	0	0
Manufact	246	246	246	246	246
Power	635	635	635	635	635
Municipal	111	111	111	111	111
Total	995	995	995	995	995
1991					
Agricul	2	2	2	2	2
Mineral	0	0	0	0	1
Manufact	298	254	313	281	317
Power	802	740	887	747	856
Municipal	136	119	141	128	145
Total	1239	1115	1344	1159	1321
2001					
Agricul	3	2	3	2	3
Mineral	1	1	1	1	1
Manufact	364	250	407	312	424
Power	1021	853	1203	926	1124
Municipal	148	109	159	130	167
Total	1536	1214	1772	1372	1719
2011					
Agricul	3	1	3	2	4
Mineral	1	1	1	1	1
Manufact	446	225	549	341	538
Power	1307	964	1649	1063	1362
Municipal	161	94	188	133	185
Total	1919	1285	2390	1541	2090

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 23 - ST. JOHN & ST. CROIX (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	2	2	2	2	2
Mineral	0	0	0	0	0
Manufact	7	7	7	7	7
Power	29	29	29	29	29
Municipal	17	17	17	17	17
Total	54	54	54	54	54
1991					
Agricul	2	2	2	2	2
Mineral	0	0	0	0	0
Manufact	8	7	9	8	9
Power	36	33	40	34	39
Municipal	20	18	21	19	22
Total	67	60	72	63	71
2001					
Agricul	3	2	3	2	3
Mineral	0	0	0	0	0
Manufact	10	7	11	9	11
Power	46	39	54	42	51
Municipal	22	16	24	20	25
Total	81	63	92	72	90
2011					
Agricul	3	1	3	2	4
Mineral	0	0	0	0	0
Manufact	12	6	14	10	14
Power	59	44	75	48	62
Municipal	24	14	28	20	28
Total	98	65	120	80	107

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 23 - ST. JOHN & ST. CROIX (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2	2	2	2	2
1991	2	2	2	2	2
2001	3	2	3	2	3
2011	3	1	3	2	4

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 23 - ST. JOHN & ST. CROIX (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2	2	2	2	2
1991	2	2	2	2	2
2001	3	2	3	2	3
2011	3	1	3	2	4

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 23 - ST. JOHN & ST. CROIX (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2	2	2	2	2
1991	2	2	2	2	2
2001	3	2	3	2	3
2011	3	1	3	2	4

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 23 - ST. JOHN & ST. CROIX (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 23 - ST. JOHN & ST. CROIX (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	1
2001	1	1	1	1	1
2011	1	1	1	1	1

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 23 - ST. JOHN & ST. CROIX (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 23 - ST. JOHN & ST. CROIX (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	133	133	133	133	133
1991	149	127	152	151	148
2001	179	121	186	168	190
2011	215	105	230	182	235

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 23 - ST. JOHN & ST. CROIX (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	246	246	246	246	246
1991	298	254	313	281	317
2001	364	250	407	312	424
2011	446	225	549	341	538

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 23 - ST. JOHN & ST. CROIX (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	7	7	7	7	7
1991	8	7	9	8	9
2001	10	7	11	9	11
2011	12	6	14	10	14

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 23 - ST. JOHN & ST. CROIX (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	635	635	635	635	635
1991	802	740	887	747	856
2001	1021	853	1203	926	1124
2011	1307	964	1649	1063	1362

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 23 - ST. JOHN & ST. CROIX (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	635	635	635	635	635
1991	802	740	887	747	856
2001	1021	853	1203	926	1124
2011	1307	964	1649	1063	1362

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 23 - ST. JOHN & ST. CROIX (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	29	29	29	29	29
1991	36	33	40	34	39
2001	46	39	54	42	51
2011	59	44	75	48	62

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 23 - ST. JOHN & ST. CROIX (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	111	111	111	111	111
1991	136	119	141	128	145
2001	148	103	159	130	167
2011	161	94	188	133	185

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 23 - ST. JOHN & ST. CROIX (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	111	111	111	111	111
1991	136	119	141	128	145
2001	148	109	159	130	167
2011	161	94	188	133	185

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 23 - ST. JOHN & ST. CROIX (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	17	17	17	17	17
1991	20	18	21	19	22
2001	22	16	24	20	25
2011	24	14	28	20	28

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 24A - NEW BRUNSWICK COASTAL (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	5	5	5	5	5
Mineral	23	23	23	23	23
Manufact	137	137	137	137	137
Power	244	244	244	244	244
Municipal	31	31	31	31	31
Total	441	441	441	441	441
1991					
Agricul	6	5	6	6	7
Mineral	30	28	30	26	35
Manufact	153	130	154	156	149
Power	308	284	340	287	328
Municipal	37	32	39	35	38
Total	534	478	569	509	558
2001					
Agricul	7	5	7	6	8
Mineral	42	35	42	40	43
Manufact	184	124	186	174	192
Power	392	327	461	355	431
Municipal	40	29	44	36	43
Total	665	520	741	611	719
2011					
Agricul	8	4	8	7	10
Mineral	59	44	59	55	51
Manufact	222	107	226	190	238
Power	502	370	633	408	523
Municipal	43	25	53	37	48
Total	835	549	979	697	869

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011,
BASIN 24A - NEW BRUNSWICK COASTAL (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	5	5	5	5	5
Mineral	54	54	54	54	54
Manufact	343	343	343	343	343
Power	244	244	244	244	244
Municipal	31	31	31	31	31
Total	677	677	677	677	677
1991					
Agricul	6	5	6	6	7
Mineral	69	64	69	59	81
Manufact	381	322	382	390	368
Power	308	284	340	287	328
Municipal	37	32	39	35	38
Total	801	707	836	776	822
2001					
Agricul	7	5	7	6	8
Mineral	98	81	97	92	99
Manufact	455	306	458	432	471
Power	392	327	461	355	431
Municipal	40	29	44	36	43
Total	991	748	1067	921	1053
2011					
Agricul	8	4	8	7	10
Mineral	137	101	136	127	117
Manufact	546	261	552	470	580
Power	502	370	633	408	523
Municipal	43	25	53	37	48
Total	1236	761	1382	1049	1278

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24A - NEW BRUNSWICK COASTAL (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	5	5	5	5	5
Mineral	4	4	4	4	4
Manufact	7	7	7	7	7
Power	12	12	12	12	12
Municipal	5	5	5	5	5
Total	33	33	33	33	33
1991					
Agricul	6	5	6	6	7
Mineral	6	5	6	5	7
Manufact	8	7	8	8	7
Power	15	14	17	14	16
Municipal	6	5	6	5	6
Total	40	36	42	38	42
2001					
Agricul	7	5	7	6	8
Mineral	8	7	8	7	8
Manufact	9	6	9	9	9
Power	19	16	23	17	21
Municipal	6	4	7	5	7
Total	49	38	53	45	54
2011					
Agricul	8	4	8	7	10
Mineral	11	8	11	10	9
Manufact	11	5	11	10	12
Power	25	18	31	20	26
Municipal	6	4	8	6	7
Total	61	39	69	52	64

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 24A - NEW BRUNSWICK COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	5	5	5	5	5
1991	6	5	6	6	7
2001	7	5	7	6	8
2011	8	4	8	7	10

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24A - NEW BRUNSWICK COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	5	5	5	5	5
1991	6	5	6	6	7
2001	7	5	7	6	8
2011	8	4	8	7	10

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24A - NEW BRUNSWICK COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	5	5	5	5	5
1991	6	5	6	6	7
2001	7	5	7	6	8
2011	8	4	8	7	10

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 24A - NEW BRUNSWICK COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	23	23	23	23	23
1991	30	28	30	26	35
2001	42	35	42	40	43
2011	59	44	59	55	51

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24A - NEW BRUNSWICK COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	54	54	54	54	54
1991	69	64	69	59	81
2001	98	81	97	92	99
2011	137	101	136	127	117

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24A - NEW BRUNSWICK COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	4	4	4	4	4
1991	6	5	6	5	7
2001	8	7	8	7	8
2011	11	8	11	10	9

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 24A - NEW BRUNSWICK COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	137	137	137	137	137
1991	153	130	154	156	149
2001	184	124	186	174	192
2011	222	107	226	190	238

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24A - NEW BRUNSWICK COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	343	343	343	343	343
1991	381	322	382	390	368
2001	455	306	458	432	471
2011	546	261	552	470	580

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24A - NEW BRUNSWICK COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	7	7	7	7	7
1991	8	7	8	8	7
2001	9	6	9	9	9
2011	11	5	11	10	12

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 24A - NEW BRUNSWICK COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	244	244	244	244	244
1991	308	284	340	287	328
2001	392	327	461	355	431
2011	502	370	633	408	523

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24A - NEW BRUNSWICK COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	244	244	244	244	244
1991	308	284	340	287	328
2001	392	327	461	355	431
2011	502	370	633	408	523

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24A - NEW BRUNSWICK COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	12	12	12	12	12
1991	15	14	17	14	16
2001	19	16	23	17	21
2011	25	18	31	20	26

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 24A - NEW BRUNSWICK COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	31	31	31	31	31
1991	37	32	39	35	38
2001	40	28	44	36	43
2011	43	25	53	37	48

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24A - NEW BRUNSWICK COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	31	31	31	31	31
1991	37	32	39	35	38
2001	40	29	44	36	43
2011	43	25	53	37	48

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24A - NEW BRUNSWICK COASTAL (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	5	5	5	5	5
1991	6	5	6	5	6
2001	6	4	7	5	7
2011	6	4	8	6	7

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 24B - NOVA SCOTIA (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	3	3	3	3	3
Mineral	11	11	11	11	11
Manufact	284	284	284	284	284
Power	874	874	874	874	874
Municipal	88	88	88	88	88
Total	1260	1260	1260	1260	1260
1991					
Agricul	4	3	4	3	4
Mineral	18	17	18	16	21
Manufact	356	302	367	334	381
Power	1103	1017	1220	1027	1176
Municipal	106	93	110	101	112
Total	1587	1431	1719	1482	1695
2001					
Agricul	4	3	4	4	5
Mineral	22	18	22	20	25
Manufact	442	299	471	383	507
Power	1404	1172	1653	1273	1546
Municipal	115	85	125	103	128
Total	1987	1577	2276	1782	2211
2011					
Agricul	5	2	5	4	6
Mineral	27	20	27	26	28
Manufact	552	267	616	431	644
Power	1797	1325	2268	1461	1873
Municipal	125	73	149	105	142
Total	2507	1688	3065	2028	2693

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011, BASIN 24B - NOVA SCOTIA (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	3	3	3	3	3
Mineral	16	16	16	16	16
Manufact	356	356	356	356	356
Power	874	874	874	874	874
Municipal	88	88	88	88	88
Total	1337	1337	1337	1337	1337
1991					
Agricul	4	3	4	3	4
Mineral	27	25	27	23	31
Manufact	445	378	462	415	479
Power	1103	1017	1220	1027	1176
Municipal	106	93	110	101	112
Total	1685	1516	1822	1570	1803
2001					
Agricul	4	3	4	4	5
Mineral	33	27	33	29	36
Manufact	552	376	593	473	640
Power	1404	1172	1653	1273	1546
Municipal	115	85	125	103	128
Total	2107	1663	2408	1882	2355
2011					
Agricul	5	2	5	4	6
Mineral	40	30	40	39	41
Manufact	688	339	778	530	815
Power	1797	1325	2268	1461	1873
Municipal	125	73	149	105	142
Total	2656	1769	3240	2139	2876

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 24B - NOVA SCOTIA (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	3	3	3	3	3
Mineral	1	1	1	1	1
Manufact	17	17	17	17	17
Power	0	0	0	0	0
Municipal	13	13	13	13	13
Total	35	35	35	35	35
1991					
Agricul	4	3	4	3	4
Mineral	2	2	2	2	2
Manufact	20	17	20	20	20
Power	0	0	0	0	0
Municipal	16	14	17	15	17
Total	41	35	42	40	43
2001					
Agricul	4	3	4	4	5
Mineral	3	2	3	2	3
Manufact	24	16	24	22	25
Power	0	0	0	0	0
Municipal	17	13	19	15	19
Total	48	34	50	43	52
2011					
Agricul	5	2	5	4	6
Mineral	4	3	4	3	3
Manufact	29	14	29	24	32
Power	0	0	0	0	0
Municipal	19	11	22	16	21
Total	56	30	60	47	62

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 24B - NOVA SCOTIA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3	3	3	3	3
1991	4	3	4	3	4
2001	4	3	4	4	5
2011	5	2	5	4	6

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24B - NOVA SCOTIA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3	3	3	3	3
1991	4	3	4	3	4
2001	4	3	4	4	5
2011	5	2	5	4	6

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24B - NOVA SCOTIA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	3	3	3	3	3
1991	4	3	4	3	4
2001	4	3	4	4	5
2011	5	2	5	4	6

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 24B - NOVA SCOTIA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	11	11	11	11	11
1991	18	17	18	16	21
2001	22	18	22	20	25
2011	27	20	27	26	28

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24B - NOVA SCOTIA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	16	16	16	16	16
1991	27	25	27	23	31
2001	33	27	33	29	36
2011	40	30	40	39	41

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24B - NOVA SCOTIA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	2	2	2	2	2
2001	3	2	3	2	3
2011	4	3	4	3	3

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 24B - NOVA SCOTIA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	284	284	284	284	284
1991	356	302	367	334	381
2001	442	299	471	383	507
2011	552	267	616	431	644

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24B - NOVA SCOTIA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	356	356	356	356	356
1991	445	378	462	415	479
2001	552	376	593	473	640
2011	688	339	778	530	815

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24B - NOVA SCOTIA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	17	17	17	17	17
1991	20	17	20	20	20
2001	24	16	24	22	25
2011	29	14	29	24	32

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 24B - NOVA SCOTIA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	874	874	874	874	874
1991	1103	1017	1220	1027	1176
2001	1404	1172	1653	1273	1546
2011	1797	1325	2268	1461	1873

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24B - NOVA SCOTIA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	874	874	874	874	874
1991	1103	1017	1220	1027	1176
2001	1404	1172	1653	1273	1546
2011	1797	1325	2268	1461	1873

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24B - NOVA SCOTIA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 24B - NOVA SCOTIA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	88	88	88	88	88
1991	106	93	110	101	112
2001	115	81	125	103	128
2011	125	73	149	105	142

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24B - NOVA SCOTIA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	88	88	88	88	88
1991	106	93	110	101	112
2001	115	85	125	103	128
2011	125	73	149	105	142

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24B - NOVA SCOTIA (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	13	13	13	13	13
1991	16	14	17	15	17
2001	17	13	19	15	19
2011	19	11	22	16	21

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 24C - PRINCE EDWARD ISLAND (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	1	1	1	1	1
1991					
Agricul	1	1	1	1	1
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	2	1	2	2	2
2001					
Agricul	1	0	1	1	1
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	2	1	2	2	2
2011					
Agricul	1	0	1	1	1
Mineral	0	0	0	0	0
Manufact	0	0	0	0	1
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	2	1	2	2	3

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011,
BASIN 24C - PRINCE EDWARD ISLAND (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	1	1	1	1	1
1991					
Agricul	1	1	1	1	1
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	2	2	2	2	2
2001					
Agricul	1	0	1	1	1
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	2	1	2	2	2
2011					
Agricul	1	0	1	1	1
Mineral	0	0	0	0	0
Manufact	0	0	1	0	1
Power	0	0	0	0	0
Municipal	1	1	1	1	1
Total	2	1	2	2	3

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 24C - PRINCE EDWARD ISLAND (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	0	0	0	0	0
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	1	1	1	1	1
1991					
Agricul	1	1	1	1	1
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	1	1	1	1	1
2001					
Agricul	1	0	1	1	1
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	1	1	1	1	1
2011					
Agricul	1	0	1	1	1
Mineral	0	0	0	0	0
Manufact	0	0	0	0	0
Power	0	0	0	0	0
Municipal	0	0	0	0	0
Total	1	1	1	1	1

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 24C - PRINCE EDWARD ISLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	1	1	1	1	1
2001	1	0	1	1	1
2011	1	0	1	1	1

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24C - PRINCE EDWARD ISLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	1	1	1	1	1
2001	1	0	1	1	1
2011	1	0	1	1	1

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24C - PRINCE EDWARD ISLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	1	1	1	1	1
2001	1	0	1	1	1
2011	1	0	1	1	1

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 24C - PRINCE EDWARD ISLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24C - PRINCE EDWARD ISLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24C - PRINCE EDWARD ISLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 24C - PRINCE EDWARD ISLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	1

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24C - PRINCE EDWARD ISLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	1	0	1

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24C - PRINCE EDWARD ISLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 24C - PRINCE EDWARD ISLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24C - PRINCE EDWARD ISLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24C - PRINCE EDWARD ISLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 24C - PRINCE EDWARD ISLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	1	1	1	1	1
2011	1	1	1	1	1

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24C - PRINCE EDWARD ISLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	1	1	1	1	1
2011	1	1	1	1	1

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 24C - PRINCE EDWARD ISLAND (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 25 - NEWFOUNDLAND (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	1	1	1	1	1
Mineral	50	50	50	50	50
Manufact	81	81	81	81	81
Power	84	84	84	84	84
Municipal	68	68	68	68	68
Total	284	284	284	284	284
1991					
Agricul	1	1	1	1	1
Mineral	65	60	64	55	75
Manufact	91	78	93	91	94
Power	106	97	117	98	113
Municipal	80	70	84	76	84
Total	342	306	359	322	367
2001					
Agricul	1	1	1	1	2
Mineral	91	76	90	86	92
Manufact	108	76	114	100	120
Power	134	112	158	122	148
Municipal	86	63	95	78	95
Total	421	328	459	387	457
2011					
Agricul	2	1	2	1	2
Mineral	128	94	127	119	109
Manufact	128	67	139	108	147
Power	172	127	217	140	179
Municipal	94	54	115	81	104
Total	524	344	600	448	542

SUMMARY OF GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011, BASIN 25 - NEWFOUNDLAND (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	1	1	1	1	1
Mineral	577	577	577	577	577
Manufact	84	84	84	84	84
Power	84	84	84	84	84
Municipal	68	68	68	68	68
Total	813	813	813	813	813
1991					
Agricul	1	1	1	1	1
Mineral	739	681	734	628	860
Manufact	95	81	97	95	98
Power	106	97	117	98	113
Municipal	80	70	84	76	84
Total	1020	931	1033	898	1156
2001					
Agricul	1	1	1	1	2
Mineral	1041	869	1032	979	1056
Manufact	112	79	118	104	125
Power	134	112	158	122	148
Municipal	86	63	95	78	95
Total	1375	1124	1405	1284	1426
2011					
Agricul	2	1	2	1	2
Mineral	1466	1081	1451	1357	1250
Manufact	133	70	145	112	153
Power	172	127	217	140	179
Municipal	94	54	115	81	104
Total	1866	1333	1929	1691	1688

SUMMARY OF CONSUMPTIVE WATER USE BY SCENARIO AND YEAR,1981-2011
BASIN 25 - NEWFOUNDLAND (MCM/YEAR)

SECTOR/YR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981					
Agricul	1	1	1	1	1
Mineral	2	2	2	2	2
Manufact	1	1	1	1	1
Power	0	0	0	0	0
Municipal	10	10	10	10	10
Total	14	14	14	14	14
1991					
Agricul	1	1	1	1	1
Mineral	3	3	3	3	4
Manufact	1	1	1	1	1
Power	0	0	0	0	0
Municipal	12	10	13	11	13
Total	17	15	18	16	19
2001					
Agricul	1	1	1	1	2
Mineral	4	3	4	4	4
Manufact	2	1	2	1	2
Power	0	0	0	0	0
Municipal	13	10	14	12	14
Total	20	15	21	18	22
2011					
Agricul	2	1	2	1	2
Mineral	6	4	6	5	5
Manufact	2	1	2	2	2
Power	0	0	0	0	0
Municipal	14	8	17	12	16
Total	23	14	27	20	25

SUMMARY OF AGRICULTURAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 25 - NEWFOUNDLAND-LABRADOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	1	1	1	1	2
2011	2	1	2	1	2

SUMMARY OF AGRICULTURAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 25 - NEWFOUNDLAND-LABRADOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	1	1	1	1	2
2011	2	1	2	1	2

SUMMARY OF AGRICULTURAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 25 - NEWFOUNDLAND-LABRADOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	1	1	1	1	2
2011	2	1	2	1	2

SUMMARY OF MINERAL EXTRACTION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 25 - NEWFOUNDLAND-LABRADOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	50	50	50	50	50
1991	65	60	64	55	75
2001	91	76	90	86	92
2011	128	94	127	119	109

SUMMARY OF MINERAL EXTRACTION GROSS WATER USE BY SCENARIO AND YEAR, 1981-201
BASIN 25 - NEWFOUNDLAND-LABRADOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	577	577	577	577	577
1991	739	681	734	628	860
2001	1041	869	1032	979	1056
2011	1466	1081	1451	1357	1250

SUMMARY OF MINERAL EXTRACTION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-201
BASIN 25 - NEWFOUNDLAND-LABRADOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	2	2	2	2	2
1991	3	3	3	3	4
2001	4	3	4	4	4
2011	6	4	6	5	5

SUMMARY OF MANUFACTURING WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 25 - NEWFOUNDLAND-LABRADOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	81	81	81	81	81
1991	91	78	93	91	94
2001	108	76	114	100	120
2011	128	67	139	108	147

SUMMARY OF MANUFACTURING GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 25 - NEWFOUNDLAND-LABRADOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	84	84	84	84	84
1991	95	81	97	95	98
2001	112	79	118	104	125
2011	133	70	145	112	153

SUMMARY OF MANUFACTURING CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 25 - NEWFOUNDLAND-LABRADOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	1	1	1	1	1
1991	1	1	1	1	1
2001	2	1	2	1	2
2011	2	1	2	2	2

SUMMARY OF POWER GENERATION WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 25 - NEWFOUNDLAND-LABRADOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	84	84	84	84	84
1991	106	97	117	98	113
2001	134	112	158	122	148
2011	172	127	217	140	179

SUMMARY OF POWER GENERATION GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 25 - NEWFOUNDLAND-LABRADOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	84	84	84	84	84
1991	106	97	117	98	113
2001	134	112	158	122	148
2011	172	127	217	140	179

SUMMARY OF POWER GENERATION CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 25 - NEWFOUNDLAND-LABRADOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	0	0	0	0	0
1991	0	0	0	0	0
2001	0	0	0	0	0
2011	0	0	0	0	0

SUMMARY OF MUNICIPAL WATER INTAKE BY SCENARIO AND YEAR, 1981-2011
BASIN 25 - NEWFOUNDLAND-LABRADOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	68	68	68	68	68
1991	80	70	84	76	84
2001	86	61	95	78	95
2011	94	54	115	81	104

SUMMARY OF MUNICIPAL GROSS WATER USE BY SCENARIO AND YEAR, 1981-2011
BASIN 25 - NEWFOUNDLAND-LABRADOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	68	68	68	68	68
1991	80	70	84	76	84
2001	86	63	95	78	95
2011	94	54	115	81	104

SUMMARY OF MUNICIPAL CONSUMPTIVE USE BY SCENARIO AND YEAR, 1981-2011
BASIN 25 - NEWFOUNDLAND-LABRADOR (MCM/YEAR)

YEAR	SCEN.1	SCEN.2	SCEN.3	SCEN.4	SCEN.5
1981	10	10	10	10	10
1991	12	10	13	11	13
2001	13	10	14	12	14
2011	14	8	17	12	16

Inquiry on Federal Water Policy

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WATER AND CANADIAN AGRICULTURE: SELECTED ISSUES

by

Gary Bowden and Marv Anderson

Canada

Inquiry on Federal Water Policy
Research Paper # 18

WATER AND CANADIAN AGRICULTURE: SELECTED ISSUES

by

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April 1985

THE INQUIRY ON FEDERAL WATER POLICY

The Inquiry on Federal Water Policy was appointed by the federal Minister of the Environment in January of 1984 under the authority of the Canada Water Act. The members were Peter H. Pearse, chairman; Françoise Bertrand, member; and James W. MacLaren, member. The Inquiry was required by its terms of reference to review matters of water policy and management within federal jurisdiction and to make recommendations.

This document is one of a series of research papers commissioned by the Inquiry to advance its investigation. The views and conclusions expressed in the research papers are those of the authors. Copies of research papers and information on the series may be obtained by writing to the Enquiry Centre, Environment Canada, Ottawa, Ontario K1A 0H3.

Frank Quinn

Frank Quinn
Director of Research

Abstract

This paper reviews selected issues in water use in Canadian agriculture. Agriculture is a major consumptive user of water in Canada, and as production grows, water consumption may increase significantly - particularly for irrigated agriculture in the Prairie provinces. Associated with the expansion of agriculture across Canada are concerns about resource degradation-soil erosion and salinity, flow depletion, water quality deterioration, and adverse impacts from drainage.

Implicit in the recognition of these concerns is that water is no longer freely available for use in agriculture. This requires in turn a re-thinking of past approaches where governments have been almost universally willing to underwrite the majority of costs associated with supplying water for agriculture.

Recognizing that using water in agriculture may impose costs elsewhere in the economy does not necessarily mean that use in agriculture should be curtailed, however. There needs to be consideration of whether the gains from use in agriculture exceed the costs imposed elsewhere. As far as federal participation is concerned, it is not clear that this question is being consistently asked.

It should be, and the report recommends application of the federal benefit-cost guidelines to projects in which there is federal participation. It is also recommended that consistent standards and procedures for federal participation in water resources development in Canada be established.

Résumé

Ce rapport passe en revue quelques-unes des questions reliées à l'utilisation de l'eau pour l'agriculture au Canada. L'agriculture est une importante consommatrice d'eau au Canada et, la quantité d'eau consommée pourrait augmenter de façon importante à mesure que la production croîtra; ceci est particulièrement vrai dans le cas de la culture à partir de terres irriguées dans les Prairies. Certaines préoccupations peuvent être associées à une expansion de l'agriculture à travers le Canada: dégradation des ressources - érosion et augmentation de la salinité des sols, diminution de la quantité d'eau disponible, détérioration de la qualité de l'eau et impacts négatifs du drainage des terres.

Le fait que l'eau n'est dorénavant plus disponible gratuitement pour l'utilisation en agriculture est sous-jacent à ces préoccupations. Cette situation exige que l'attitude antérieure des gouvernements qui consistait à accepter d'absorber la majorité des coûts associés aux projets d'approvisionnement en eau pour l'agriculture soit repensée.

La reconnaissance du fait que l'utilisation de l'eau en agriculture puisse résulter en des coûts suplémentaires quelques part ailleurs dans l'économie ne signifie pas nécessairement que les quantités utilisées devraient être réduites. On se doit de vérifier si les bénéfices engendrés par l'utilisation de l'eau en agriculture sont supérieurs aux coûts imposés ailleurs. Il n'apparaît pas clairement que cette question soit posée de façon constante au niveau de la participation fédérale.

Ceci devrait pourtant être le cas et le rapport recommande la mise en application des lignes directrices fédérales de bénéfices-coûts pour les projets auxquels le gouvernement fédéral participe. Il est aussi recommandé que des normes et procédures consistantes appliquables à la participation du gouvernement fédéral dans le développement des ressources hydriques soient établies.

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INTRODUCTION

This report is written in response to the Terms of Reference issued by the Inquiry on Federal Water Policy for a report on Water and Canadian Agriculture.

The Terms of Reference ask for a number of specific topics to be addressed, including: projections of future agricultural use of water; the capability of agricultural water users to pay for water-related services; adverse impacts of agricultural expansion on other water uses; documentation and critique of federal policies and programs; and recommended changes in federal policies and programs. These tasks follow a logical sequence, and the report is organized into five sections which correspond to them.

It has not been possible to respond to the call for projections of trends in agriculture with more than very broad estimates. This reflects the nature of projections dealing with agriculture, which, because of the fragmented nature of the industry, are necessarily imprecise.

There is a concentration on federal water-related policies and programs in the Prairie provinces. The authors confess, unabashedly, to this "bias". It reflects both the geographic focus of federal programs themselves, and the fact that it is in the Prairie provinces that the continued availability of water for agriculture is an emerging issue.

The report does not find a clearly defined federal policy which focusses on water in agriculture. There is, in Environment Canada, a broad policy with respect to water, and, in Agriculture Canada, policies dealing directly with agriculture. Within each of these are components which deal with water in agriculture. In broad terms the policies are consistent. Insofar as they endorse the efficient use of resources so that Canadians can derive the "greatest social and economic benefit" therefrom, there is little to criticize.

What is identified, however, is a lack of scrutiny to ensure that federal actions do serve the broad policy objectives. The scope of this study does not extend to the evaluation or assessment of specific programs or proposals, nor to a retrospective evaluation of various projects. We are limited, therefore, to the observation that without a commitment to consistent, rigorous, program and project evaluation there can be no assurance that federal activities dealing with water in agriculture will in fact contribute to the "greatest social and economic benefit" for Canadians. Application of principles that have already been enunciated in the federal benefit-cost guidelines to programs and projects dealing with water in agriculture would do much to ensure both efficiency and consistency - which are presently lacking.

1. AREA AND YIELD PROJECTIONS AND IMPLICATIONS FOR USE OF WATER

Agriculture is a major water user in Canada. Daily withdrawals from surface or ground water reservoirs are estimated at 8 billion litres. This is far less than the 37 billion litres withdrawn for use in manufacturing or the 54 billion withdrawn for thermal power generation. But, unlike these other major water users, over 50 percent of the water withdrawn for agriculture is consumed, primarily for irrigation and stock watering. The result is that in terms of actual consumption of water, agriculture ranks higher than any other industry (17).

Significant changes in the nature or magnitude of the agriculture industry could have important implications for water resources. In the same context the availability and cost of water may have a strong bearing on the future direction of agriculture in many areas of Canada. Of particular interest in this paper is how anticipated changes in agricultural acreage and yields will impact on the water resource, in both a quantitative and qualitative context.

Land Base

The process of change in Canada's agricultural land base is markedly different between what have been described as the "agricultural heartlands" of the east and west. In the western heartlands, west of the Manitoba-Ontario border, the years 1961 to 1976 saw an increase of 2.5 million hectares in total farmland, and, significantly, a greater increase of 3.7 million hectares in improved farmland. During the same period the eastern heartlands, primarily in Ontario, recorded a decrease of 3.9 million hectares in total farmland, and 1.3 million hectares in improved farmland (32).

These trends are expected to continue, with significant expansion of the agricultural land base limited largely to the Prairie provinces. Projections of changes in the **improved area** in western Canada indicate that it will continue to increase at least until 1990, and probably well beyond (1, 8, 14, 23). While there are differences of opinion regarding the projections, an estimate of approximately 120,000 additional hectares per year is probably a reasonable rate of increase to expect to 1990 (8).

In the Prairie provinces these projected increases do not appear to be conditional upon strong market prices. Rather the phenomenon has been on-going since at least 1951 and reflects the structure of agriculture in those provinces (45). Data for Alberta, for example, indicate that relatively strong agricultural prices during the early 1970s were correlated with a decline in the rate of growth in cultivated area while relatively soft prices in the late 1970s were correlated with an increase in

the rate of growth in cultivated area.

The annual increase in improved area in the Prairie provinces will continue to come largely from three sources, conversion of improved pasture to cropland, drainage of wetlands and reduction of summerfallow.

Converting 10 percent of the improved pasture to crop land could increase the cropped area on the Prairies by roughly 300,000 hectares (about 1 percent), based on 1981 Census data. The on-going drainage of wetlands, however, is the most likely source of additional cultivated area. If one assumes that the wetland areas on the Prairies are approximately equivalent to 10 percent of the total cropped area in size, and that half of this area could be economically drained, this would add about 5 percent, or 1.2 million hectares, to the 1981 cropped land base. Increasingly, the agricultural policy thrust across Canada is being directed towards getting these wetlands into production (2,13,15).

The current trend towards summerfallow reduction across the Prairies will further increase the cropped area. One study suggests that summerfallow acreage may decline by 20 percent in Alberta, 24 percent in Saskatchewan and 33 percent in Manitoba, over the decade 1981 to 1990 (8).

Elsewhere in Canada the prospects for significant increases in the improved or cultivated area are not as strong. In British Columbia opportunities to expand the agricultural land base are limited, and any major new expansions will require withdrawals from competing uses (forestry, recreation). Government policy has in recent years favored the release of Crown land to agriculture, and has included low interest loans for land clearing. The efficacy of these policies is currently being questioned, however, and in the next decade expansion of the cultivated land base is expected to be far below the 16,000 hectares per year average of the 1961 to 1976 period.

Ontario experienced a decline of 390,000 hectares of improved farmland, 1961 to 1976. On balance this decline is expected to continue, although it is expected that some new land will be added to the improved category, partially offsetting other land that is withdrawn. Drainage of wetlands is likely to be the greatest source of new improved farmland in Ontario. Some 1,200,000 hectares are presently serviced by subsurface drains, and one estimate indicates that there are an additonal 1,500,000 hectares which would benefit from installation of such drains (38).

In Quebec and the Atlantic provinces there was a collective reduction of 2.6 million hectares of total farmland, 1961 to 1976, and a reduction of 955,000 hectares of improved farmland. Some abatement in the rate of decline is expected, and drainage programs may bring some additional land into production, particularly in Nova Scotia (36). Overall, however, expansion in the agricultural land base is not forecast for Quebec and the

Atlantic provinces (with the exception of some small areas in Newfoundland).

Yield Changes

Yield projections for both western and eastern Canada are optimistic with regard to growth potential (1, 8, 23). Overall, the expected average annual yield increase for Western Canada is expected to be about 1 percent. This estimate gives considerable weight to the yield depressing impacts of expanding onto inferior lands, and continued soil degradation (31). Yield increases in eastern Canada can be expected to be of the same magnitude.

Yield increases typically arise from several sources, the most important being:

a) Dryland Cultural Practices

Greater use of fertilizers and agricultural chemicals and the adoption of water management strategies (snow trapping, shelterbelts) are on-going changes which improve crop yields. The management aspect in farming is becoming more critical to obtaining top yields (through variety selection, timing of operations, and related matters).

b) Genetic Improvements

Research scientists are involved in developing varieties which are more drought resistant, respond better to fertilizer and mature more quickly than those currently in use. While the importance of genetic improvements to overall yield increases is uncertain, recent estimates suggest that they may account for 20 percent of total yield increases (31).

c) Irrigation

A profile of the present extent of irrigation in Canada is provided in Table 1.1. Perhaps 5 percent of the farmers in Canada have some irrigation; about 1 percent of the improved farmland in Canada is irrigated.

Irrigation in Canada is concentrated in the west, and within the west primarily in Alberta. In 1980, nearly 400,000 hectares were irrigated in Alberta, approximately 100,000 in British Columbia, 56,000 in Saskatchewan and 7,000 in Manitoba. Elsewhere in Canada there are about 40,000 hectares under irrigation in each of Ontario and Quebec. In the Atlantic provinces irrigation is much more limited, less than 3,000 hectares, and frequently resorted to only in very dry years.

Irrigated yields for any given crop are much higher than under dryland conditions, although yields obtained in production still remain far below the potential achieved under experimental conditions (29, 39). There is a significant potential to increase the irrigated area in Canada, which would lead to both increased yields for some crops, and in some areas shifts to new crops to take advantage of water availability.

In British Columbia irrigated area is expected to continue to grow by some 1,000 hectares per year through to about 1995. In the Prairie provinces there are an estimated 2.8 million hectares in the South Saskatchewan River basin which are suitable for irrigation, .5 million hectares of which might be irrigable with conventional irrigation practices and existing water supplies in that basin (5). In Alberta in the next two decades an increase of 150,000 hectares over 1982 levels is a realistic growth projection. The Alberta Minister of Agriculture has recently announced a $150 million, five year, program for rehabilitation and expansion of irrigation systems. The long term goal of the program is to increase irrigable area by 160,000 hectares by 1995.

With the development of the Gardiner Dam in Saskatchewan irrigation potential was estimated to be approximately 160,000 hectares. Although only some 55,000 hectares are currently irrigated, projected growth to 1990 is approximately 2,500 hectares per year (23). In Manitoba the expansion of irrigated agriculture is not expected to exceed 250 hectares per year over the next decade, from a current base of some 7,000 hectares.

In Ontario, where 40,000 hectares are presently under irrigation, any future increase in irrigated area for major crops (corn, soybeans, white beans) is expected to be constrained by the availability of water, as well as labor and capital costs (38). Prospects for increased irrigation area in Ontario are, therefore, modest, and the situation in Quebec is similar. In the Atlantic provinces the expectations regarding irrigated area are also modest. Irrigation is expected to continue to be relied on during very dry years, and there may be some growth in connection with the expansion of horticultural production.

Overall Output Changes

There are several projections of increased production for the Prairie provinces. One, summarized in Table 1.2, indicates an increase of approximately 9 million tonnes (21%) over 1981 production to just over 50 million tonnes by 1990 (8). The major contributors to this increase are expected to be new land, 21.3%, reduced fallow, 48.5%, and improved yields, 30.2%. Other projections (23) call for production in the three Prairie provinces to be between 43 and 49 million tonnes by 1990. Both projections suggest that crop production approaching 50 million tonnes may be possible on the Prairies by 1990.

Longer term, 1975 - 2000, supply response projections for the west by Agriculture Canada for two levels of price increases are even more optimistic - an increase of 77% for the low price scenario and 100% for the high price scenario (1). Similarly, grain production (to 2000) for eastern Canada has been calculated to increase by 117% for the low price scenario, and 131% for the high price scenario over 1975 levels (1). The source of the production increase in the east would be largely yield improvements, as opposed to increases in the land base which are expected to contribute significantly in the west.

Implications for Use of Water

The major implication of the projected changes in agricultural output for use of water arises from direct withdrawal for irrigation. Other implications include water quality, as affected by erosion and siltation, and use of water by others which will be affected both by irrigation withdrawals and wetland drainage. These latter implications are addressed in Section 3 of this report and are touched on only briefly here.

The impact on regional water use of increasing the area under irrigation will depend on factors such as the kind of crops grown and average consumptive use (gross diversion less return flow). Unit consumptive use, in turn, depends on precipitation levels, irrigation operating practices and irrigation efficiencies. During the period 1973 to 1978 water use per acre in five Alberta irrigation districts ranged from 3,700 to 5,800 cubic metres per hectare (1.2 to 1.9 acre feet per acre) (4).

If irrigation efficiencies remain similar in future it implies a requirement of about 4,000 cubic metres of water for each additional irrigated hectare (1.5 acre feet per acre). With some 200,000 hectares of additional irrigation expected on the Prairie provinces, this implies a requirement for an additional 800 million cubic metres (750,000 acre feet) of water annually by about 1995. This is the most concentrated requirement seen across the country. The additional irrigation in British Columbia will require in the order of 4 million cubic metres per year, from diverse sources scattered throughout the province.

In Ontario and Quebec combined the expansion can be expected to require roughly 3 to 4 million cubic metres per year. Additional requirements in the Atlantic provinces will be far less, probably not even 5 percent of the forecast for Ontario and Quebec.

These requirements are predicated on maintaining present water use efficiencies. Between 1961 and 1978 effective irrigation water use efficiencies in the Alberta portion of the Saskatchewan- Nelson River basin were estimated to be between 47 and 63 percent in every year except 1966. Any improvement that can be achieved in irrigation efficiencies implies lower water losses and more area irrigated per unit of water delivered. To the extent that water management can be improved, irrigated areas can actually increase with no increase in the volume of water

diverted for irrigation purposes. Because of the potential for such increases, the above estimates should be regarded as upper limit water requirements for expanded irrigated area.

Projections of increased agricultural production through expansion of the land base have focussed concern on the resource degradation issue. New lands tend to be more marginal, for one reason or another, and subject to greater risk even with the application of modern farming techniques. Greater on-farm water erosion will in all likelihood be associated with expansion of the land base, with consequent adverse impacts on water quality. Offsetting or dampening this impact, the current direction of dryland cultural technologies will improve on-farm water management, and the anticipated reduction in summer fallow will reduce water erosion problems (as well as secondary soil salinity).

The availability of water to be used by others will be directly affected by irrigation withdrawals, and also by draining and consolidation of wetlands. Increased agricultural use of wetlands will impact directly on water use through:

- drainage, which will reduce the number and area of surface water bodies, thereby augmenting streamflows and decreasing groundwater levels,

- intensifying the conflicts over the use of remaining water resources.

Composite projections for agricultural water use to the year 2011, by drainage basin, in terms of both withdrawals and consumption, are provided in Table 1.3. These projections suggest "more of the same". Already regionally concentrated water demands for agriculture are generally expected to become even more concentrated.

Finally, it should be noted that the implications traced above assume that the future will reflect the past. In particular, it is generally assumed in making agricultural projections that the market price for water (to agricultural producers) will continue to be near-zero. In contrast, implicit real price changes for land, fertilizer, and other inputs are considered in these projections. This effectively means that the technological evolution envisaged has a strong bias in favor of irrigation-intensive options.

Under different price or policy assumptions regarding the supply of water for use in agriculture, it is reasonable to expect that output can be increased with a much less than proportional increase in the use of water. Indeed it is conceivable that the output projections could be realized with little or no change in water demand - through better use and managment of available precipitation, crop expansion and intensification excluding irrigation expansion.

Table 1.1

IRRIGATION IN CANADA, 1971 and 1981

Province/Region	No. of Farms*			Irrigation Farms as % of Total Farms	Irrigated Area (ha.)			Irrigated Area as % of Total Improved Land
	1971	1981	% Change		1971	1981	% Change	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Newfoundland	8	n.a.	-	1.2	50	n.a.	-	0.5
P.E.I.	17	n.a.	-	0.5	219	n.a.	-	0.1
Nova Scotia	160	n.a.	-	3.2	755	n.a.	-	0.4
New Brunswick	138	n.a.	-	3.4	1,267	n.a.	-	0.2
MARITIMES	323	-	-	2.5	2,291	-	-	0.4
QUEBEC	2,418	n.a.	-	5.0	37,609	n.a.	-	1.6
ONTARIO	3,880	n.a.	-	4.7	40,272	n.a.	-	0.9
Manitoba	151	283	87%	1.0**	2,968	6,935	134%	0.1**
Saskatchewan	918	1,277	39%	1.9**	31,372	55,913	78%	0.3**
Alberta	3,678	4,159	13%	7.2**	217,539	393,969	81%	3.1**
PRAIRIES	4,747	5,919	25%	3.8**	251,879	456,817	81%	1.2**
B. C.	5,794	6,706	16%	33.5**	89,468	100,475	12%	10.6**
C A N A D A	17,162	n.a.	-	5.4***	421,519	n.a.	-	0.9***

* Number of farms with at least some irrigation.
** In 1981. All based on farm numbers and farmland areas in 1981.
*** In 1971. Based on farm numbers and farmland areas in 1981.

Source: Statistics Canada, Census of Agriculture, 1971 and 1981.

Table 1.2

TOTAL POTENTIAL PRODUCTION INCREASE
IN THE PRAIRIE PROVINCES TO 1990

Crop	Production 1981 (,000 tonnes)	Increase ,000 Tonnes	Increase Percent
Crop:			
Wheat	23,835	3,874.5	16.2
Oats	2,529	785.8	31.1
Barley	12,628	3,467.7	27.5
Flaxseed	468	131.6	28.1
Canola	1,814	548.0	30.2
TOTAL	41,274	8,807.6	21.3

Basic Source: (8)

TABLE 1.3

AGRICULTURAL* WATER USE, 1981 and 2011 PROJECTIONS
(millions of cubic metres)

Drainage Basin	Withdrawals			Consumption		
	1981	2011 low	2011 high	1981	2011 low	2011 high
1.Pacific Coastal	--	--	--	--	--	--
2.Fraser-Lower Mnld.	258	214	543	144	120	304
3.Okanagan-Similk.	254	300	681	142	122	307
4.Columbia	33	27	70	18	15	39
5.Yukon	--	--	--	--	--	--
6.Peace-Athabasca	--	--	--	--	--	--
7.Mackenzie	--	--	--	--	--	--
8.Arctic Coastal	--	--	--	--	--	--
9.Milk	46	43	108	38	34	88
10.N. Saskatchewan	94	86	220	76	70	178
11.S. Saskatchewan	1963	1804	4586	1586	1457	3704
12.Assiniboine-Red	188	172	440	152	139	355
13.Winnipeg	1	1	2	1	1	2
14.Lower Sask.-Nelson	28	26	65	22	21	53
15.Churchill	--	--	--	--	--	--
16.Keewatin	--	--	--	--	--	--
17.Northern Ontario	--	--	--	--	--	--
18.Northern Québec	--	--	--	--	--	--
19.Great Lakes	129	110	273	107	90	230
20.Ottawa	28	23	57	24	20	51
21.St. Lawrence	65	52	132	64	51	130
22.North Shore & Gaspé	8	6	16	8	6	15
23.St. John-St. Croix	2	1	4	2	1	4
24.Maritime Coastal	8	6	17	8	6	17
25.Newfoundland	1	1	2	1	1	2

* Includes irrigation and stockwatering

Source: Adapted from D. Tate, Alternative Forecasts of Canadian Water Use, 1981-2011, forthcoming Research Paper for Inquiry on Federal Water Policy, Ottawa 1985.

2. CAPABILITY OF AGRICULTURAL PRODUCERS TO PAY FOR WATER-RELATED SERVICES [ON-FARM ECONOMIC BENEFITS]

This section of the report addresses the component of the Terms of Reference which calls for analysis of ".... the capability of agricultural producers to pay for water-related services (e.g. irrigation, drainage projects) in relation to other water users." In so doing it deals first with the capability of agricultural producers to pay for water-related services, a capability which is defined to derive from, or be equated with, the net on-farm economic benefits from those services. Following that there is a brief review of how that capability relates to other users of the water resource, and finally a discussion of the prevailing practices in charging for water-related services.

Capability to Pay [On-Farm Economic Benefits]

The phrase "capability to pay" is customarily used in discussions of public finance to refer to the wealth or income of taxpayers. In this report, however, a more stringent definition has been adopted. We are not interested in the absolute wealth or income of farmers, but in the net economic gains (or income) which they derive from water-related services. This provides what we believe to be a more relevant measure for the purposes of the Inquiry, and for addressing the balance of this component of the terms of reference "... in relation to other water users."

Irrigation and drainage services will contribute to on-farm economic gains in a variety of ways. In the case of irrigation, gains may arise from intensification, diversification and enhanced income stability. Crop intensification can be dramatic, and in areas where supplemental moisture has a relatively high payoff yields can be increased by factors of from 2 to 10, depending on the crop. Diversification opportunities are also important. With irrigation farmers can, by growing a wider variety of crops and in some cases by integrating livestock production and feed production, reduce the variability of their incomes. Finally, because moisture levels can be managed through irrigation, production levels are less volatile and incomes are further stabilized.

> "The drought of 1980 is a prime example of the value of irrigation when livestock operations in Saskatchewan had to rely to a large degree on Alberta produced forage to maintain dairy and breeding herds. The benefit of irrigation during periods of drought is but one factor that has been neglected in determining the viability of Canadian irrigation projects." (17)

Through often complex interactions, forces such as those identified above increase the net income or economic gains which farmers may realize from the use of their land. In the case of irrigation it is generally anticipated that there will be an increase in gross annual incomes, from greater yields or from a shift to new and more valuable crops. When all of the costs incurred in order to generate the increases in gross income are deducted, the balance or incremental net economic gain represents the contribution of the irrigation water to income. If the full costs of labor and all other inputs are deducted in calculating this residual, it also represents the amount that could be paid for the irrigation water - the farmer's "capability to pay" as defined for this paper.

In the case of drainage services provided to land the analysis would follow the same principles, with the net economic gain or "capability to pay" deriving from the net contribution of the drainage service to annual income.

The net economic gains realized by landowners, or on-farm economic benefits, from irrigation have been examined in numerous studies. Two approaches are favoured: an "accounting" approach in which costs and returns are estimated on the basis of accepted production standards; and a land value approach where inferences about the net gains realized by landowners are drawn from comparison of the market values (selling prices or annual rents) of irrigated and non-irrigated land.

The estimates derived from the "accounting" approach are sensitive to variations in assumed product prices and yields, and are both crop and site specific. Despite this, over fairly wide areas the estimates correspond reasonably well, and are actually quite consistent for individual crops. Estimates of the maximum long-term economic value of water for agricultural purposes in southern Alberta suggest an average value of from $100 per hectare ($40 per acre) to $210 per hectare ($84 per acre). For some individual crops (corn silage, sugar beets, potatoes), however, the values are estimated to be from $375 to $850 per hectare ($150 to $340 per acre) (28).

A recent United States study suggested that the absolute maximum ability to pay for water would be around $120 per acre-foot ($300 per hectare for crops requiring one acre foot of water). This is above the average for southern Alberta, but is not inconsistent with the estimates for some of the higher valued crops (22).

As discussed subsequently, it has not been the practice in Canada to base the charges for irrigation or drainage services on the contribution which they make to the primary producer's net income. To the extent that the charges for such services are less than their contribution to net income, the net gain realized by the landowner will rise. The market for farm land effectively translates this increase in the residual return into either higher annual rentals or higher land prices. By looking at land prices and rental rates, the "land value" approach draws

inferences about the value of irrigation (more specifically, about that part of the value of irrigation that is not captured in charges for the water).

Some evidence that is directly applicable to this approach can be found in the PFRA submission to this Inquiry (42) which states that dryland around Outlook, Saskatchewan may sell for $1,235 per hectare, with irrigable land selling for $1,850 per hectare ($500 and $750 per acre, respectively). Other things being equal, this difference of some $615 per hectare ($250 per acre) in the selling price of irrigated versus dryland will reflect the capitalized value of the water's net annual contribution to income - over and above what is charged for the water. These figures are reasonably comparable to those in an earlier study (28) which found a difference of $535 per hectare ($214 per acre) between the selling price of irrigated land and dryland in southern Alberta.

The Alberta study suggested that if farmers were using a discount rate of 5 per cent in capitalizing their net annual economic gains (in excess of what they pay for water fees)from irrigation, the average annual value was in the order of $27.50 per hectare ($11 per acre). Adding to this the annual per hectare water fees in the Irrigation Districts of roughly $14 ($5.50 per acre), indicates that the total contribution of irrigation water to income (the net economic gain) was in the order of $42 per hectare ($16.50 per acre). It is notable that the water fees only captured about one-third of this value, with the rest being capitalized into land values.

A similar calculation can be performed with the data for the Outlook area of Saskatchewan, referred to above. Here the difference in the selling price of irrigated versus non-irrigated land, $615 per hectare, would reflect an annual value to the farmer (in excess of water fees) of $31 per hectare ($12.50 per acre). Farmers in six PFRA projects in Saskatchewan pay $11.25 per hectare ($4.50 per acre) per year for full irrigation services (storage, conveyance and distribution). If those rates are applicable in the Outlook area, it suggests that the total contribution of irrigation water to annual incomes is, as in Alberta, about $42 per hectare ($16.50 per acre). In this case, however, it appears that only about one-quarter of the annual value is captured in the water fees, with three-quarters being capitalized into land values.

Finally, estimates of the contribution of water to incomes can also be obtained by looking at the difference in annual rents paid for irrigated versus non- irrigated land. In southern Alberta dryland is said to rent for $62 to $100 per hectare, while irrigated land rents for $148 to $200 per hectare (42). Other things being equal, the differences, $80 to $100 per hectare ($32 to $40 per acre), can be taken as a reflection of the annual net contribution of irrigation water to income - over and above what is actually paid for the water.

The estimates based on annual rentals indicate a significantly larger contribution to income than those derived from the selling price of land. These may provide a more accurate measure of the annual value of irrigation water, insofar as rental rates are directly observable and this approach requires fewer assumptions about the economic behaviour of farmers. (One factor alone, the discount rate that is assumed to be used by farmers in determining land values, can have a marked effect on the analysis which works back from differences in the selling price of land.) On the other hand, the differences between the two approaches which are noted here may simply reflect that the observations on which they are based were not derived through a rigorous selection process, and that the areas to which they refer may not be truly "comparable".

The reader is cautioned against imputing too much precision to these estimates. The more important points are that irrigation water does make a fairly substantial contribution to net annual incomes (on-farm net gains or economic benefits), and that those who supply the water capture only a fraction (one-quarter to one-third) of that value in the water fees.

The situation with respect to irrigation water is believed to be similar throughout the rest of Canada. Irrigation water will make a positive contribution to net annual income, with the magnitude of the contribution varying markedly with the type of crop being grown, location, soil, and other factors. It is also the case that, as in the examples cited above for Alberta and Saskatchewan, the charges which are levied for irrigation water generally capture only a portion of its value, as measured by its contribution to net income.

Of fundamental importance in this discussion of the value of water in irrigation is that the figures which have been examined relate only to the benefits accruing to landowners, in excess of their on-farm costs (on-farm economic benefits). It cannot be inferred from these data that there is any overall net economic gain, viewed from a province or nation-wide perspective, from irrigation. That depends on the relationship between the off-farm costs of supplying irrigation water - which are borne almost exclusively by governments - and the net gains to farmers. In subsequent discussion, which reviews pricing policy for irrigation, several references are introduced which indicate that the total gains in agricultural production fall far short of the costs of supplying irrigation water.

Circumstances are much the same for drainage services, which can greatly increase agricultural productivity and income (38). We do not have any estimates of the annual contribution of drainage to net incomes, which would in any event tend to be somewhat more site-specific than those for irrigation. As discussed subsequently, charges levied for drainage services do not appear to be based on the contribution to income.

Capability to Pay Relative to Other Users

Agricultural producers generally do not have the same capacity to pay for water as many other users, as indicated by a comparison of the value of water in alternative uses. In both agriculture and industrial uses the value of water is derived from the interaction of product prices and other input costs. In comparison with other industrial uses, the value of water in agriculture is relatively low. This in part reflects the extensive nature of water use in agriculture, as contrasted with more intensive application in many industries.

Estimates from the United States, although somewhat dated, indicate that the value of water in industrial uses will generally be twenty times, or more, higher than in agriculture (see Table 2.1). A more recent comparison indicates that in California the value added per unit of water is 65 times greater in industry than in agriculture (40). The value of water in agriculture does appear to be higher than for either waste load assimilation or hydroelectric power generation (Table 3.4), but much lower than its value in the other non-industrial uses listed.

In making these comparisons between the value of water in alternative uses it should be emphasized that the relative values do not imply that all water should be allocated to the highest valued use, e.g., industry. The actual consumption of water by industry is modest in any event, and as more water was applied to industrial uses the value of the additional water would decline rapidly. A more appropriate goal is to try to allocate water among uses so that its incremental or marginal contribution in each use is roughly equal.

In this context the data from Table 2.1 do not suggest that no water should be allocated to agriculture. They do suggest, however, that extensive agricultural application of water (irrigation) should probably be the marginal user - being supplied only after other demands have been met, and being reduced in favor of other uses in cases of shortage. The exceptions would be waste assimilation and hydroelectric power generation where the data indicate values in crop irrigation to be higher. These are of course broad generalizations, and the particular circumstances surrounding alternative water uses would have to be carefully examined in making actual allocation decisions.

One brief to the Inquiry suggests that we are now approaching the point where those kinds of allocation choices will have to be made. That brief (18) suggests that on the Prairie provinces instream uses have generally been met from the unused portions of water available, with exceptions in low flow years in some basins. This suggests that either those instream uses have been protected in decisions to licence withdrawals for other uses (primarily agricultural and municipal), or that to date there has been sufficient water to meet all demands. The

latter is probably the case in most circumstances, and the brief emphasizes that as the unused portion of available water diminishes, provision will have to be made to adjudicate between competing uses.

Pricing Policy, Water-Related Services to Agriculture

As noted in reviewing the capability of farmers to pay for water-related services, only a part of the on-farm economic benefits (or value) from the use of water is actually recovered in water fees. And while there are often substantial on-farm economic gains from irrigation, it is not clear that irrigation projects generate overall net economic benefits when the off-farm costs of water supply are set off against the on-farm gains. We review here the common approaches to pricing for water-related services, and some information on the latter question - the overall relationship between benefits and costs of irrigation projects.

There are numerous observations, as noted above, about the value of water (the on-farm economic benefits and related capacity to pay) in irrigation. The prices charged for water-related services have not been based on that criterion, however. Instead, historical water management policies in Canada have generally contained elements of three basic approaches to establish what should be paid:

1. Pricing on the basis of the financial costs of providing the service;

2. Pricing on the basis of the beneficiaries' capability to pay;

3. Pricing on the basis of social goals including income redistribution, economic stability, or regional development, and in relation to the socio-economic benefits derived from the service.

Pricing on the basis of the total financial costs involved in providing a water-related service has been almost universally rejected in agriculture, because the direct net farm benefits are almost invariably less than the total costs involved. (This is readily apparent when one considers the relatively small amount of private irrigation that takes place without government intervention.)

Pricing strictly on the capability-to-pay basis (derived, as defined above, from the on-farm net economic gains) requires judgments about the cost or value of various inputs, including the operator's labor, and the resulting estimates vary widely between various areas and for different crops. For these reasons, pricing on the capability to pay basis has not been attractive.

Given the rejection of the above two approaches to pricing, what has emerged can best be described as pricing on the basis of the distribution of economic impacts, or gross economic activity generated. The costs of providing water-related services tend to be pro-rated between direct beneficiaries (farmers) and others on the basis of the ratios between on-farm incomes and "spin-off" economic activity and associated government revenues. Governments of various levels bear directly the share of the costs which would be attributed to the non-farm sectors of the economy. This approach in effect represents a "weak" application of the first two approaches, and a heavy reliance on the third which is seen as justifying the use of water resources to attain "socio-political" goals.

These kinds of analyses are frequently looked upon as providing project justification, for which they are not appropriate, and for which they have been criticized with varying degrees of harshness:

> "Secondary (indirect) benefits can only be counted as benefits within the effeciency analysis if resources are unemployed ... and the spinoff activity truly represents a net gain in economic acitivity and ... the unemployment of resources would be chronic over the life of the project. (Thus), in general, economists remain reluctant to justify projects in terms of their secondary benefits ... Their proper role relates to the objective of regional income distribution as well as to questions of repayment and pricing...." (51).

> "... certain errors in economic reasoning have played a role (in the historical mis-allocation of water resources): among them ignorance of the marginal principle, double counting of benefits, and the use of inappropriately low discount rates. Some advocates of irrigation not only fail to understand economics but also the simplest principles of accounting, and are unable even to distinguish gross from net returns ...." (12).

Information on current practices in pricing or cost sharing for irrigation and drainage services is reviewed below.

Irrigation

A number of government cost-sharing programs are in place to promote soil and water conservation and water enhancement on the Prairies. Alberta Agriculture provides 60 percent funding of eligible costs on projects to control soil erosion, soil salinity, slough consolidation, drainage and channel improvement. It is also responsible for 86 percent cost-sharing of the capital cost of district irrigation system rehabilitation. Alberta Environment provides 75 percent cost-sharing of eligible engineering and capital costs in general water management projects. In effect, with respect to irrigation

in Alberta, this probably means that the farmers' historical contribution to total water delivery costs has not exceeded 5 to 10 percent of off-farm capital costs.

Similar cost-sharing formulae have encouraged irrigation development in Saskatchewan. And a 50-50 capital cost sharing program (for 5 or more farmers interested in irrigation) is also available through the PFRA. In addition numerous provincial and federal technical support services are also provided free of charge to the farmer.

In Alberta existing irrigation farmers (through their largely self-governing Irrigation Districts) are subject to relatively low water rates. The requirement for Alberta Agriculture to pay 86 percent of the cost of system rehabilitation confirms that historical water rates have not been adequate to finance on-going operations and required maintenance. Relatively low water rates also characterize most other irrigation projects in Canada. For example, farmers in six PFRA projects in Saskatchewan pay only $11 per hectare ($4.50 per acre) per year for full irrigation services (storage, conveyance and distribution).

Drainage

There is very little research which specifically focusses on the quantitative long-term socio-economic costs and benefits of drainage. The cost-sharing arrangements for drainage, as indicated in Table 2.2, reflect a similar farmer-government split to those in irrigation.

Summary

Review of present pricing policy for water-related services to agriculture indicates that governments are almost universally willing to underwrite the majority of costs associated with the provision of those services. Thus not only is there no attempt to charge the user for the water resource consumed in irrigation, only a small proportion of the associated costs of delivery of the water to the farm are recovered.

This has probably been necessary for most projects to proceed at all, given the estimate in one recent study that farmers' ability to contribute to off-farm irrigation infrastructure costs (both capital and current) probably does not exceed one half of required operation and maintenance costs and perhaps 10 percent of total costs (30). Given that the farmer's capability to contribute to those off-farm costs derives from the value generated by the water in its on-farm application, if an overall view is taken of the relation between the benefits of such projects and their costs, it is clear that the benefits will fall far short of the costs. It is difficult to argue, therefore, that there is any net economic gain, viewed from the perspective of the national economy in particular, from most irrigation projects.

This willingness to proceed with projects where the direct beneficiaries are able to defray only a fraction of total costs can perhaps be partly explained by a belief that in many areas the availability of water is a critical constraint to growth and that without it there will be little or no development in a given area (18, 27). Thus not only is the on-farm production seen to result from the supply of water, but the associated economic activity in processing and provision of services to the agriculture sector are also attributed to it. This reflects a somewhat parochial view of economic activity, for while economic activity within any given geographic area may depend on the availability of water, if the resources required for a project were employed elsewhere in the economy they could well generate equivalent or greater levels of activity.

Finally, regardless of the analyses and supporting assumptions which justify public cost sharing, the greatest impetus for additional irrigation development on the Prairies comes from government agencies which continue to adhere to their original mandate - water supply enhancement. In this context the central issue is probably not the farmer's ability to pay but rather the general public's willingness to pay for continued water supply enhancement, irrespective of the long term social, environmental and economic consequences.

> "... these analytical errors have had much less practical significance than what might be called the non-analytical error. This is the belief, usually quite unconscious, that there are fixed "needs" or "requirements" for water rather than economic demands. No matter how conclusively it is refuted by facts -- for example the experience, which is all too common, of the inability to sell high-priced water -- the belief that demands are absolutely inelastic continues to dominate much planning in this field." (12)

Table 2.1

LONG-RUN NATIONAL DIRECT VALUE OF WATER IN THE UNITED STATES*

($U.S. 1972/Acre-Foot Gross)

Use	Value/Acre-Foot**		Comment
Crop Irrigation	$5-20	($3)	Relatively Low
Domestic	16-101	($187)	Relatively High
Industrial	100-300	($74)	Relatively High
Waste Load Assimilation	.03-7.60	($1)	Relatively Low
Recreation	0-150	(n.a.)	Relatively High
Fish and Wildlife	7-13	(n.a.)	
Hydroelectric	.14-1.00	($)	Relatively Low

* Excludes spinoff value added

**Estimate from [12] for 1974 indicated in brackets.

Source: Colorado State University, Economic Value of Water, Concepts and Empirical Estimates, National Technical Information Service, Springfield, Va., 1972

Table 2.2

EXISTING PROVINCIAL CAPITAL COST SHARING FORMULA FOR DRAINAGE - 1984

(percent)

	On-Farm			Off-Farm[e]		
Region	Farmer	Government	Total	Farmer	Government	Total
Province						
N.B.	50	50	100			
N.S.	25	75	100			
P.E.I.	50	50	100			
Newfoundland	-	-	-			
Quebec	50[a]	50[a]	100			
Ontario	(b)			67[f]	33[f]	100
Manitoba	-	-	-	0[g]	100[g]	100
Saskatchewan	33[c]	67[c]	100			
Alberta				25	75	100
B.C.	(d)			33	67	100

[a] Approximate. Assumes a 70¢/meter subsidy for tile drainage = ½ installed price.

[b] Eight percent loans.

[c] For drainage in Irrigation Districts.

[d] Four percent loans.

[e] In those provinces for which detailed information is unavailable and/or unduly complex, various subsidies generally apply.

[f] For Southern Ontario. The ratios are reversed in Eastern and Northern Ontario.

[g] Only applied to certain classes of drainage facility.

3. ADVERSE IMPACTS OF AGRICULTURAL EXPANSION ON OTHER USES OF WATER

The impacts of agricultural expansion on other uses of the water resource will vary greatly across the country. The nature and extent of impacts will depend, among other things, on the nature of the expansion, changes in agricultural practices in both established and new areas, and the extent to which other uses will be protected where expansion involves withdrawal and consumption of water in agriculture. This section of the report is concerned with adverse impacts, such as erosion, salinization, contamination and flow depletion which may follow from expected agricultural expansion. We include some discussion of the economic losses associated with agricultural impacts on water resources, and means of reducing those impacts.

Flow Depletion

As noted in Section 1, the major implication of the projected changes in agricultural output for use of water arises from direct withdrawal and consumption for irrigation. The impacts of these additional water requirements on other uses of water will be very site-specific.

In British Columbia a significant portion of new requirements is expected to come from groundwater wells. Although the amount withdrawn is not expected to have a measurable effect on groundwater supplies, relatively little is known about aquifers in that province. Other requirements will be met by surface withdrawals from streams, lakes and rivers. These are licenced, and while in early years licences were granted with little regard for other water uses, the licencing process now generally requires that adequate flows remain to meet the needs of insitu uses - such as fish and wildlife, recreation, or waste assimilation. Moreover, it can be anticipated that an increasing proportion of future surface withdrawals will be provided for by diversion or storage projects. These augment flows on a seasonal basis when they are required for irrigation, thus further ensuring the provision of water for other insitu uses.

On the Prairie provinces there will be little use of groundwater to meet additional agricultural requirements, surface withdrawals being the only practical source of providing most irrigation water. From briefs submitted to the Inquiry it appears that some major projects may be required if the water requirements implicit in the various projections are to be met (18, 27, 42, 43).

Whether the governments of the Prairie provinces will continue to be willing to commit water to agricultural uses, and to provide as well the necessary funds for construction and on-going operation of major projects, is unknown. To the extent that they do, such actions will imply either that they have, in

their views, provided adequately for other water uses, or in the event that other uses are compromised in favour of agriculture, have judged the use of water in agriculture to be of a higher value.

This of course presumes that information on the value of water in alternative uses, and consistent evaluation criteria, will be available and readily applied in making decisions on the allocation of water. There is no guarantee, of course, that this will happen, and several briefs to the Inquiry have expressed concerns that evaluation criteria and decision making frameworks have failed to adequately account for non-agricultural values in the past. (2, 10, 18)

Concerns of this nature are reinforced by the generally accepted observations, as discussed in Section 1 of this report, that the costs of most large agricultural water supply projects have outweighed the benefits. That being the case, it is frequently presumed that there should be no further allocation of water to agriculture, and there is an inherent distrust of analyses that contemplate such uses. It does not seem appropriate here, however, to prejudge future projects or analyses and reject them out of hand. There may well be circumstances in which agriculture represents the most valuable use of water, and there will undoubtedly be others in which it does not.

Therefore, while flow depletion caused by increased withdrawals for agriculture clearly poses the potential for impacts on other water uses in the Prairie provinces, it is not a simple matter to predict the magnitude of those impacts. The additional requirements for agriculture may be met by flow enhancement, through diversions and storage facilities, leaving intact the requirements of other uses; or there may be some degree of encroachment on other uses. It would be out of place to comment here on whether the provinces are likely to make "good" or "bad" decisions regarding water allocation in future. With the attention that has been drawn to non-agricultural values in the present era, however, it does seem reasonable to expect that future decisions will at least be better informed than some taken in the past.

In Ontario, irrigation requirements are presently met from surface water and to a lesser degree ground water. It is expected that additional requirements would be met from the same sources, in roughly the same proportions. The impact this will have on other water uses is not expected to be substantial. Permits are required for both surface and groundwater withdrawals for irrigation quantities in excess of 50,000 litres per day (11,000 gallons), and the permits for surface withdrawals require the protection of the natural functions of streams and provide a mechanism for allocating available flows among users (38). A means for taking account of non-agricultural values in making decisions about the future allocation of water to agriculture clearly exists in Ontario. Its success in guiding "optimal" allocation decisions will depend on the quality of information

which is made available as future decisions are taken.

In the Atlantic provinces irrigation demands are expected to be modest, as are potential impacts of flow depletion on other uses.

Soil Degradation (Salinization and Erosion)

Several briefs to the Inquiry emphasize that soil and water problems are inseparable and must be considered together (11, 15). Some soil problems directly affect the water resource (erosion), while others result from the on-farm use of water (salinization). In either case the cultural practices which may be adopted to counter erosion and salinization themselves have implications for water use, hence the logic of considering these soil degradation problems in the context of water management. This is particularly important in the context of agricultural expansion, as expansion onto marginal arable lands may exacerbate both salinization and erosion.

Salinization

The salinization of agricultural lands is one of a number of soil degradation problems threatening agricultural production in Canada. Crop yields are very responsive to soil salinity levels, with yield reductions of 50 percent not uncommon in saline areas (16,44).

"Secondary" or man-induced salinity is a result of the addition, redistribution or concentration of soluble salts by groundwater or surface water (16). A primary cause of soil salinization in western Canada appears to be the practice of summerfallowing, which permits the deep percolation of excess water. Thus, while soil salinization appears to result in part from water use practices, it does not in itself appear to impact on other uses of water resources.

The extent of the salinity problem is the subject of some debate. Some recent estimates and projections for western Canada to 2008, excluding irrigated areas and areas of unimproved pasture, are presented in Table 3.1. These indicate something in excess of 1 million hectares (2.5 million acres) presently affected by secondary salinity, with 1.25 million hectares (3.1 million acres) expected to be affected by the year 2008, an increase of 10,000 hectares (24,000 acres) per year (16).

Salinization is less extensive, although proportionally no less serious, on irrigated lands in western Canada. Estimates of approximately 100,000 hectares (250,000 acres) affected appear reasonable (19, 33). Unlike dryland salinity, the salinization of irrigated lands results principally from seepage, inefficient irrigation practices and poor surface drainage (3).

Salinity control and mitigation is very dependent upon on-going improvements in farm management practices (16):

- use of deep-rooted perennial crops to dry out the soil profile;

- more intensive cropping with the gradual elimination of summerfallowing in saline-prone areas;

- surface and sub-surface drainage;

- utilization of effective snow management practices; and

- the planting of salt-tolerant crops.

The future extent of this salinity control in the context of an expanding agriculture will, in turn, affect agricultural water use. The major considerations in this regard are:

- the additional water necessary for leaching saline soils under irrigation will increase the pressure on available water supplies;

- the trend in summerfallow acreage reductions, with the resultant increase in stubble cropping, will tend to increase the variability of crop yields and, hence, the importance of on-farm water management strategies.

- reductions in water losses from irrigation canals will serve a two-fold function of reducing irrigated saline areas, and making more water available for productive uses.

Some estimates place the annual cost of salinity to crop producers at $29 million, expected to grow to $465 by the end of the century (11), while others indicate the annual cost to be $100 million already, and growing by about 1 percent each year (16, 44). This latter estimate suggests that current losses are equal to 1.5 percent of the total value of annual Prairie crop production.

Given the magnitude of these estimated losses, it would appear that farmers have strong economic incentives to introduce cultural practices which will control salinity. The response of individual farmers can be expected to be highly varied, however. Some may recognize the problems and have adequate financial resources to take corrective measures, while others who are equally cognizant of the problems may, because of financial pressures, not alter their cultural practices. Still others may simply be slow to recognize the problems with salinity and begin to consider the various corrective actions which can be taken. Thus, while it does not seem reasonable to project that the extent of salinization will continue to grow unabated, it may be some time before there is any significant reversal in recent trends.

Erosion

As with salinity, the impact of erosion on crop yields can be dramatic. In some studies wheat yields have been shown to be only one-third as great on eroded as compared to non-eroded soil (33,44). The negative yield effects of erosion have been shown to be a function of soil type, amount of topsoil eroded and, to a lesser extent, crop grown (16).

The area of improved land in western Canada that has been affected by soil erosion is substantial, with estimates for 1984 approaching 5.2 million hectares (13 million acres) and projections for an additional 1.0 million hectares (2.5 million acres) by 2008 (Table 3.2). While soil erosion rates vary with climatic factors, topography and soil surface factors, in general bare soils are much more erodable than ones covered with plant growth (16). The various management practices which increase the susceptibility of soils in western Canada to erosion include the use of large equipment, summerfallowing, high tillage speeds, elimination of windbreaks, cultivation of submarginal soils and incorporation of pre-emergent herbicides.

In addition to the Prairie region identified in Table 3.2, serious water and wind erosion areas exist in the potato growing regions of New Brunswick and Prince Edward Island, the Annapolis Valley of Nova Scotia, the corn belt of southern Ontario, and the lower mainland of British Columbia (44).

The extent of erosion in future will depend on the soil and water management strategies adopted by farmers. Some of the management changes which are currently being made should have a positive effect. Others, in particular expansion onto marginal areas, will result in greater erosion problems.

The economic incentives to reduce soil erosion appear to be strong. One source indicates that on-farm losses on the Prairie provinces are in the order of $370 million annually and will grow to $472 million by the end of the century if unchecked (11). Others place the current annual losses at from $368 to $468 million in the western provinces, and as great as $68 million in southern Ontario alone (41,44). The response to the costs of erosion by individual farmers can be expected to vary, however, for the same reasons noted in discussing the response to salinization.

In terms of direct agricultural water use it is anticipated that on balance the impact of cultural practices introduced to deal with erosion should either be neutral or slightly positive (reducing consumption), as indicated by the assessment in Table 3.3. Erosion will continue, however, and is expected to spread to new areas with expansion onto submarginal lands. The increased silt loadings in rivers and streams may adversely affect other downstream users, with the effects ranging from increased costs to remove silt from drainage and shipping channels, to fish and wildlife and recreation losses (27).

Drainage

As noted in Section 1 of this report, there is expected to be continuing emphasis on getting wetlands into agricultural production. We have chosen to discuss the water management concerns that this gives rise to under two headings. One can perhaps be characterized as the hydrological effects - the impacts on streamflows and flood peaks within river basins. The other has to do with elimination of surface waterbodies and their withdrawal from use for other purposes.

Hydrological Effects

The use of subsurface drains to improve soil aeration and permit timely cultivation has historically been very important to agricultural production in many areas of Canada. This importance has not diminished, and in recent years increased land drainage, along with genetic advances in corn production, are credited with the establishment of feedgrain self-sufficiency in Ontario and improved self-sufficiency in Quebec (50). This has been a specific goal in Ontario, and the Ontario Ministry of Agriculture and Food estimates that in addition to the 1.2 million hectares (3 million acres) already served by subsurface drains, a further 1.5 million hectares (3.8 million acres) would benefit from the installation of such drains (38). Associated with extensive subsurface field drains, there are frequently improvements to local drainage channels, and often connecting channels which drain swamps and ponds.

There tend to be intuitive expectations that these works have led, and will continue to lead, to greater and more frequent flooding elsewhere in the affected river basins. Careful investigations have not supported such expectations, however, and in many cases refute them (26).

It is difficult to generalize, when hydrological responses will vary with different types of drainage works and differing climate and physiographic conditions. But it has been found that in most cases subsurface drainage and outlet enlargement have little effect on flood peaks, and that flood peaks are reduced when high water table areas are drained. This apparent paradox arises in large part from the fact that tile or other subsurface drainage provides storage capacity in the soil, tending to reduce surface runoff and decrease peak flows. On the other hand, the connection of swamps or enclosed areas to rivers by large arterial drains, does increase flood peaks (26). It is not uncommon to find, moreover, that whereas drainage may be blamed for increased flood peaks or frequency, encroachment of buildings and fill in river channels and on flood plains is actually the primary cause.

The extent to which increased agricultural drainage will create problems for water management through these "hydrological" effects will thus depend very much on the nature of the works. Expansion of on-farm drainage to improve soil aeration and permit effective cropping may in fact have little effect. Major channel improvement or drainage of areas that provide some surface storage may have significant effects. The latter type of projects, almost always undertaken by government agencies or with government funding, are at least easily identifiable and should be subject to review for such adverse effects before they are undertaken.

Drainage of Surface Waterbodies

The functions of a wetland are many, including the provision of habitat for a wide variety of fish and wildlife species which contribute in turn to numerous forms of recreation (10). Drainage terminates these wetland functions, a matter of concern to many who benefit from them (15, 18, 37).

Concern over the continuing loss of wetlands is serious, taken in the context of some estimates which indicate that two-thirds of the original Prairie wetlands have already been drained (15). Some evidence indicates, moreover, that wetlands are being lost at an increasing rate (6). Canadian Wildlife Service observations indicate that drainage, filling and cultivation of semipermanent and permanent wetlands is occurring at a rate of 18 percent per year in the Prairie provinces. Correspondingly, populations of mallard ducks have been declining since the early 1970s and are currently at all time lows thoughout the Prairies (6).

It is indicated in Section 1 that if half of the Prairie wetlands could be economically drained it would add 1.2 million hectares (3 million acres) to the cropped land base - an increase of about 3 percent. While that may be a speculative estimate, further loss of wetlands to this extent would be viewed with considerable alarm vis a vis the probable impacts on waterfowl.

These kinds of concerns over wetland losses are not unique to the Prairie provinces. In Ontario agricultural reclamation is pointed to as a major force in the loss of wetlands (37), and numerous interests see agricultural drainage as a major threat to that province's remaining wetlands.

Their function in providing waterfowl habitat illustrates the complexity of the wetlands drainage issue. Migratory waterfowl are a continental resource, managed jointly under Convention by Canada, the United States and Mexico. Canadian wetlands are vitally important to many species as nesting habitat (7, 21). The recreational benefits supported by the waterfowl which nest in Canada are enjoyed in all three countries, and are difficult to quantify.

The farmer who is contemplating draining a wetland is unlikely to realize any of the benefits from the waterfowl it supports, but may bear numerous costs as a result of the presence of the wetland. In his decision as to whether to drain the wetland he cannot be expected to give weight to the reduction in waterfowl productivity and recreational losses accruing to others - he will be guided by his own on-farm costs and benefits. Thus the impacts of wetland drainage on waterfowl are "external" to the farmer's decision making process and, in the absence of outside intervention, will not be taken into account.

Much of the concern over the loss of waterfowl nesting habitat is focussed on how to intervene in farmers' drainage decisions so that the full range of costs and benefits is considered (15, 21). This is in many respects a classic example of what economists would call a "market failure". There are no conventional market mechanisms through which those who benefit from the maintenance of waterfowl populations can register the benefits that they receive by paying for them, and thus influence landowners' decisions. In the absence of such mechanisms the preservation of wetlands and securing of such values must rely on intervention by government agencies and voluntary organizations.

The issue of wetlands preservation and waterfowl is particularly complex, involving as it does a large number of species with highly variable migratory patterns. The same principles affect the preservation of wetlands as habitat for non- migratory fish and wildlife species. Problems again arise because of the absence of market channels through which the consumers of the services that fish and wildlife provide can convey to landowners the values they attach to those services.

As long as this "market failure" persists, and those who make decisions regarding drainage of surface wetlands do not take account of the consequent reduction in fish and wildlife habitat, it is almost certain that the amount of drainage which takes place will be in excess of what would be considered optimal from the viewpoint of society at large. In view of the extent to which surface water bodies have already been eliminated, this is a serious concern.

Contamination

Finally, agricultural expansion may impact on other water uses via water quality degradation and contamination. Erosion and the consequent siltation of watercourses has already been discussed, the further concern here being with nutrients, chemicals and agriculturally-originated pollutants.

The agricultural sector can contribute to surface and groundwater contamination through runoff, the quality of which will reflect the type of soluble materials the water is in contact with, and the suspended materials it carries. Possible pollutants from agricultural land include sediment, nutrients, pesticides, organic matter and pathogens (38). Nutrients and

animal manure can reduce water palatability, pose health risks to people and animals and increase the eutrophication of waterbodies (2).

Opinions vary as to the significance of the various types of contaminants which originate in the agriculture sector. It has been indicated that in Prince Edward Island agricultural activities have been the largest source of groundwater contamination in the province, and there is increased concern about the impact of pesticide use on water resources (34). Similarly from Manitoba a concern singled out for early attention is the presence of agricultural chemicals in surface water and groundwater - something which is seen as a growing threat to the supply of potable water for farms and communities (27). Others (2, 36) suggest that pesticide residues do not contaminate water to any appreciable extent.

While there are divided views as to the degree to which agriculture is presently contributing to water contamination, the issue for this report is the extent to which other water uses may be affected, via water contamination, resulting from expansion of agriculture. As long as cultural practices are consistent it can be expected that there will be a pro-rata increase in contamination problems. Increasing attention is being paid to problems of this nature in some areas, however, with emphasis on management practices to control water pollution (38). If expansion in agriculture is coupled with improved cultural practices the increase in contamination problems may be less than proportional to the increase in agricultural production.

Economic Losses from Agricultural Impacts on Water

We have noted above some estimates of the on-farm losses arising from erosion and salinization. These arise from reduced soil productivity and not from changes in the quantity or quality of water. In addition to these direct on-farm losses, agriculture may impose off-farm costs on other water uses, via flow reduction, drainage, or contamination, as discussed.

Although they do not deal specifically with costs caused by agriculture, there have been some estimates of the economic costs due to water pollution in Canada. An early study for the Department of the Environment indicated annual losses across Canada of \$40 to \$70 million (35). Recent estimates by Environment Canada indicate the social costs of water pollution from all sources to be at least \$200 million annually (2). Although these estimates are not broken down by source of pollution, it is expected that the contribution from agriculture is modest in comparison with those from industrial and municipal sources.

These estimates deal with costs arising from water pollution only, however, and do not take account of costs that may arise when other uses are "displaced" by withdrawal of water for consumptive use in agriculture, or by drainage. Several

briefs to the Inquiry have noted that the values affected by withdrawals and drainage are not well understood (2, 9, 15, 18, 37) and stressed the need for consistent criteria for taking such values into account in resource allocation decisions. As far as is known there have been no investigations of these kinds of costs in Canada, although there have been several studies of the wetlands/waterfowl issue on a continental basis (7, 21).

Means of Reducing Adverse Impacts of Agricultural Expansion

A common response to almost any identified adverse impact is to call for its reduction or control. It is not at all clear, however, that adverse impacts resulting from agricultural use of water should universally be reduced or controlled. Whether they should or should not depends very much on the relationships between the benefits realized from the agricultural use of water and the cost of the impacts. (It also depends on the relationship between the value or cost of the impacts and the costs of corrective measures). We will attempt to illustrate this with respect to the different types of adverse impacts which agricultural expansion may have on other water uses.

In the case of **flow depletion** resulting primarily from irrigation withdrawals, the licensing process almost universally provides an avenue for the protection of other uses which depend on the water. In the past little account may have been taken of other uses, in many respects reflecting oversight but in other regards probably fairly reflecting prevailing relative values. In the present era much more attention is drawn to such uses, and it is unlikely that they will suffer just from oversight.

The question of relative values remains moot, however. When there are competing demands for water, not all of which can be satisfied from available supplies, choices between uses will have to be made. These kinds of allocation decisions are a provincial responsibility, and it is expected that, at least in the case of major projects, they will result from analyses that take alternative uses and values of water into account. Whether the allocations which ultimately result represent an optimal use of resources will depend on the "quality" of the information which is used and the rigor of the analytical framework. While almost all provinces adhere to fairly conventional benefit cost approaches, there is a persistent concern that the kinds of impact analyses on which decisions about cost sharing have been based (Section 2) may be relied on to justify particular projects in the event that their costs are otherwise shown to outweigh their benefits.

It should be inherent in analyses supporting water allocation decisions that the least cost alternatives for meeting any given objective be identified. In this regard it is important to note that efficiencies in water use in irrigation

have historically been very low. This is not surprising, since the prices charged for water have hardly provided an incentive to treat it as a scarce commodity.

In southern Alberta, recent years have, however, seen increasing attention paid to improving these efficiencies, both through improvements in on-farm application methods (sprinklers versus back flooding) and improvements in delivery systems (upgrading and repair of diversion, reservoir and headworks facilities). Other areas, too, have begun to look seriously at improving the efficiency with which water is used in irrigation (46).

There appears to be considerable scope, therefore, to meet increased irrigation demands through more efficient use of water already allocated to agriculture, rather than through increased withdrawals. Such alternatives should be fully explored, and may constitute a cost-effective means of reducing impacts from agricultural withdrawals and flow depletion.

Soil salinity and erosion have also been discussed as problems which must be addressed in a joint approach to soil and water management. As some of the estimates of economic losses indicate, these are problems with substantial direct on-farm costs. There is little that can be done in the scope of water management to reduce those on-farm costs, the remedies to which lie almost exclusively in the hands of the farmers and their cultural practices.

To the extent that the costs of available remedies are less than the benefits to be gained through their application (ie reduction in losses) it is wasteful, from a social point of view, for those losses to continue. Thus there may be a good case to be made for special programs in soil and water conservation education - to arm farmers with the knowledge of improved cultural techniques which would reduce the losses.

Not all costs of erosion are borne on-farm, however. Erosion may cause siltation which can in turn impose a variety of costs on other water users. Reducing these off-farm costs provides a further justification for programs in soil and water conservation education. In cases where the off-farm costs of erosion remain unacceptably high, stronger remedies may have to be sought. Recourse could be had to regulating on-farm cultural practices, and incentives could also be tried, perhaps paying a per acre premium to encourage the growth of crops which do not render the soil as susceptible to erosion.

As discussed above, **the drainage of surface water bodies** is a very serious problem from the perspective of waterfowl management, and in connection with non-migratory fish and wildlife species as well. The nature of this problem is widely recognized (15) but no simple solution exists.

At least two steps are required to address this problem. The first is to provide farmers and others who are making

drainage decisions with information on the value of the wetlands as wildlife (waterfowl) habitat - something which requires considerable site-specific information that is not readily available. The second, in cases where analysis indicates that the gains to the farmer from drainage do not offset the losses to others from reduced habitat, is to develop a mechanism whereby those who gain from preservation of the wetland habitat can adequately compensate the farmer for foregoing the on-farm benefits of drainage.

To date this problem has been approached largely through "collective" action, both government and voluntary. The Canadian Wildlife Service has had a program of obtaining easements over private wetlands to preserve their role as waterfowl habitat. And Ducks Unlimited, a non-profit organization which raises funds from sportsmen in both the United States and Canada, has secured some 1.4 million hectares (3.4 million acres) of wetland habitat through agreements with private landowners and government agencies (7, 15).

To the extent that these programs have been carried out they are an effective way of "internalizing the externality" so that decisions about drainage reflect both on and off-farm costs and benefits. Should these approaches be judged to be inadequate, the further alternative would seem to lie with direct government regulation of drainage.

If provincial governments are prepared to intervene and regulate drainage, this could have the salutary effect of providing incentives for rationalization of provincial cost-sharing programs for drainage. The greatest incentive for regulation probably lies with the federal government, however, given the importance of wetlands to migratory waterfowl, which are a federal responsibility. There would be an obvious need for federal provincial coordination in any such regulation, to avoid having the two levels of government working at cross purposes with respect to drainage incentives.

Finally, the issue of **water contamination** and agricultural expansion is one which is probably best dealt with through a combination of education/research and regulation. This is largely the case at present. Education and research programs are aimed at increasing awareness of the water contamination problem and of practical means of controlling agricultural non- point source pollution. Regulations deal with the use of pesticides and chemicals (38). As with any form of regulation, however, the problems of inspection and enforcement are serious - particularly when they involve, as they do in agriculture, large numbers of different pesticides and chemicals applied at many diverse points and at highly variable times.

4. FEDERAL POLICIES AND PROGRAMS WHICH INFLUENCE AGRICULTURAL DEMANDS FOR WATER

To assess and critique all federal policies and programs which influence agricultural demands for water is a broad task, and we attempt at the outset to place some limits around it. At the most general level almost any government program which promotes economic growth will stimulate the demand for food, and in turn influence agricultural demands for water. We do not propose to consider the impacts of such general government programs on the demands for water.

Similarly, although the federal government plays a major role in a number of income, price support and supply management programs for agricultural products, which undoubtedly influence agricultural demands for water, we will not consider such programs. These programs have specific goals, and whatever the controversies about their efficacy, neither in their design nor administration should there be concern about lower level resource demands or allocation issues. Although these programs will probably stimulate the agricultural demand for water, those who are responsible for them should not be concerned with the impacts of their programs on the demand for water, for example, any more than with the demand for steel, fuel or labor.

We are restricting our considerations, therefore, to those programs and policies through which activities of the federal government directly influence the use and management of water in agriculture. These include activities through Agriculture Canada and Environment Canada and the various Acts and agencies which fall within their mandates, and other Departments which have been directly involved in agricultural projects.

Agriculture Canada

In its brief to this Inquiry (2) Agriculture Canada sets out its objective:

> "To promote the growth, stability and competitiveness of the agri-food sector, by making available policies, programs and services that are most appropriately provided by a federal government, so that the sector makes its maximum real contribution to the national economy."

Under this objective Agriculture Canada has identified the sustainability and enhancement of the agricultural industry's soil and water resources as one of the major issues needing immediate attention. A five-year departmental plan is being developed, with four areas relating to national water resource development. These are:

Surveys and Monitoring - with Agriculture Canada prepared to survey and monitor actual agri-food water use and to forecast future agri-food demands. Basic and Applied Research - the department currently has resources allocated to a number of areas affecting agricultural use of water, including water conservation under reduced tillage and through improved snow management, water erosion control, water quality control, various aspects of irrigation requirements, soil salinization and drainage.

Development Programs - Agriculture Canada has become "heavily involved" in the design and implementation of regional agricultural development strategies. These take the form of coordinated programs, under federal-provincial development agreements. Since 1982 agri-food development agreements have been signed with Nova Scotia, Prince Edward Island, New Brunswick, Manitoba and Saskatchewan, and most other provincial governments are reportedly willing to support similar programs. The majority of these programs are designed to increase the speed with which the private sector adopts improved technology and management practices.

Regulation and Registration of Pesticides - the department is responsible for regulation and registration of pesticides (under the Pest Control Products Act) and coordinates the evaluation and registration process with several other federal departments.

Prairie Farm Rehabilitation Administration

The Prairie Farm Rehabilitation Administration is an agency of the federal government which was created in 1935 by the Prairie Farm Rehabilitation Act, in response to the severe drought of the 1930's. Originally under the authority of the Minister of Agriculture, PFRA was attached to the Department of Regional Economic Expansion from 1969 to 1983, and returned to Agriculture Canada in March of 1983.

PFRA's purpose is to secure the rehabilitation of the drought and soil drifting areas of Alberta, Saskatchewan and Manitoba. Amendments to the original Act in 1937 gave the PFRA three main dimensions - water development, cultural practices, and land use. To accomplish its goals it has developed and promoted, through cooperation with the provinces and industry, new farming practices, tree culture, water supplies, land use and land settlement.

The PFRA has seen its role as a developer rather than a regulator and has provided assistance for a large number of projects. Included are more than 187,000 individual and 1,500 community water development projects. Among the individual

projects are 7,200 irrigation schemes, and the community projects include 144 group irrigation schemes.

The PFRA has assisted in the development of major water supply and irrigation projects under a variety of arrangements. This has sometimes involved cost-sharing of initial project development. In others cases Canada, through PFRA, has shared in or paid the entire cost of dams, reservoirs, main canals and headworks, with the responsibility for irrigation distribution systems and other facilities assumed by the provinces or other organizations. PFRA has generally provided engineering design and construction supervision, with operation and maintenance responsibilities accepted by provincial or local authorities.

Some special PFRA undertakings include the Bow River Irrigation District in Alberta, which was purchased by the federal government in 1950, renovated and enlarged to serve victims of the drought, and transferred to Alberta in 1974. Some 23 storage reservoirs and six irrigation projects were developed in southwestern Saskatchewan to relieve effects of the drought, and the province of Saskatchewan has developed seven irrigation projects which are served by PFRA reservoirs (42).

While PFRA continues to have a highly qualified engineering organization, since completion of the Gardiner Dam on the South Saskatchewan River in the 1960's, federal involvement in the construction of major water supply projects has declined significantly (18). A change of focus can be noted in the "drought proofing" studies and irrigation project evaluation activities that PFRA has recently been involved in, cooperatively with the provinces, under the Saskatchewan and Manitoba Agreements on Water.

Canada Water Act

The Canada Water Act of 1970 replaced the Canada Water Conservation Assistance Act of 1953, which provided for federal cost-sharing with the provinces of large-scale water conservation projects. Through this Act and other sources (Economic and Regional Development Agreements) federal funding has been made available for flood control works, and various other capital projects.

Although the federal contribution to such projects dropped off significantly following completion of major projects in the 1960's, a number of projects have been recently approved, but not yet carried out. These include further flood control structures, community and on-farm water projects and water treatment for Regina-Moose Jaw. The federal agent varies from project to project, in some being Environment Canada and in others Agriculture Canada (18).

Environment Canada

With its establishment in 1970 the Department of the Environment was given "primary responsibility for administering water resources from the national point of view" (25). A statement of water policy was issued on behalf of Canada by the Minister of Environment in 1978. The broad objectives of that policy are the conservation, development and use of water resources for the greatest social and economic benefit of Canadians - present and future.

The major points which are relevant to agricultural projects and use of water include a commitment to a joint federal-provincial approach to most issues, including cost-sharing; pursuit of water quality goals through control of nutrients and chemical contaminants; and application of the federal environmental assessment and review process where federal authority extends to water projects. Federal policy calls on users to pay the costs of using water, including pollution costs, and provides for the alleviation of flood problems.

Environment Canada has not become as directly involved in agriculture-related water resource developments as has, for instance, the PFRA. More emphasis has been placed on water resource planning and river basin management, through cooperative agreements with the provinces, and there has been considerable emphasis on flood control and damage reduction. The Canadian Wildlife Service, a division of Environment Canada, has intervened in agricultural drainage, through its program of obtaining easements over private wetlands to preserve them as waterfowl habitat.

Agricultural Rehabilitation and Development Act

Under this Act the federal government entered into numerous cost-sharing Agreements with the provinces, the focus of which included comprehensive resource inventories, research into land and water use, and development of land and water resources in low income rural areas. Throughout most of its history ARDA projects were administered by the Department of Regional Economic Expansion, and it is believed that existing Agreements will continue to be administered by the new Department of Regional Industrial Expansion.

Under the umbrella of a general ARDA Agreement, it has been common for the federal and provincial governments to enter into more specific Subsidiary Agreements, to cover particular areas, or particular kinds of projects. An example of this is the Eastern Ontario Subsidiary Agreement, which ended in 1984. Under this Agreement a two-thirds grant was paid toward the cost of outlet drains, with the grant cost being shared equally between Canada and Ontario. In other parts of the country Subsidiary Agreements have been used to develop community pastures and for land reclamation purposes.

Canadian Wheat Board

Although it does not directly affect the use of water, per se, there is currently much criticism of the Wheat Board policy where quotas for the delivery of grain are tied to the acreage actually cultivated. This is claimed to have the effect of encouraging or "enforcing" the practice of summerfallowing, which in turn contributes to and exacerbates soil salinity problems. In addition it encourages the drainage and cultivation of wetlands (15).

Critique of Programs and Policies

A critique of federal programs and policies which influence agricultural use of water must take as its reference point the stated policies of the federal government with respect to the water resource. In this regard it is appropriate to reiterate the objectives noted above for both Environment Canada, and Agriculture Canada.

The objectives for Environment Canada are particularly important in view of the fact that this department has been given "primary responsibility for administering water resources from the national point of view" (25). The relevant aspects of policy as it relates to agricultural use of water include the broad objective of conservation, development and use of water resources for the greatest social and economic benefit of Canadians now and in the future; the commitment to federal-provincial cost-sharing; a call for users to pay the costs of using water; and the application of the federal environmental assessment and review process where federal authority extends to water projects.

In the case of Agriculture Canada the aspect of its stated objective that is most relevant in the context of water management is the commitment to make available policies, programs and services so that the agri-food sector makes its maximum real contribution to the national economy.

The broad objectives of these two key government departments are generally consistent insofar as they relate to water use and management. The emphasis from Environment Canada is on the use of water for the greatest social and economic benefit, with the environmental assessment and review process ensuring that a broad range of uses is included in the determination of benefits. Put simply, this is a commitment to efficient use of water and related resources. In a similar sense the Agriculture Canada commitment to a maximum real contribution to the national economy can be interpreted as requiring efficient use of water resources and a respect for non-agricultural alternatives.

It is not surprising to find common elements such as these in broad statements of departmental policy. The real test lies, however, in the actual programs which are undertaken and their adherence to the stated general principles. For purposes of assessment federal programs and policies are discussed here in terms of their economic efficiency (benefits in relation to costs), and in terms of consistency.

Economic Efficiency

In discussing the economic efficiency of programs and policies they can effectively be grouped into two major areas.

The first includes various programs for research in soil and water conservation (PFRA, Agriculture Canada, Environment Canada) provision of on-farm technical assistance (PFRA), encouragement in the adoption of techonology and management practices (Agriculture Canada, PFRA), and on-farm water supply (wells, dugouts, irrigation) (PFRA).

These kinds of programs will act in two directions in influencing the demand for and use of water. They will tend to reduce the use of water to the extent that the research in soil and water conservation, provision of on-farm technical assistance, and adoption of technology and management practices all encourage more efficient use of water. They will tend to increase the demand for or use of water, to the extent that they result in an expansion of agricultural production, or introduce water intensive practices (irrigation) where they have not previously been applied.

The relationships between the costs of these particular programs and the benefits which they generate have not been clearly documented. Research has generally shown, however, that there is a high rate of return to the application of improved technology, and to the kind of basic research undertaken in many of these programs. In addition the costs of these programs are generally quite modest, and they do not involve major changes in the allocation of resources. These programs appear to be consistent with both the broad objective stated by Environment Canada - conservation, development and use of water for the greatest social and economic benefit - and the objective of Agriculture Canada - to assist the agri-food sector in making a real contribution to the national economy.

The second major policy and program area includes the large scale projects which make water available for agriculture, or directly affect agricultural use of water and related land resources. Here we identify major water supply projects for irrigation, and drainage and land reclamation projects.

Major irrigation water supply projects have served in the past to deal with water "shortages", or meet inherent demands for water, by supply augmentation. Given the climate which gave

birth to the PFRA, the major federal agent in such projects, it is not surprising that the early projects were not subject to rigorous analyses of costs and benefits. This approach persisted, and even in the 1960's the proponents of the Gardiner Dam and the South Saskatchewan River Project apparently did not feel that it was a part of their mandate to conduct such analyses. Thus when this project was approved by the newly-elected Diefenbaker government, the decision to proceed was not supported by analysis of the project's economic efficiency.

The Gardiner Dam was the last major water supply project which involved a significant federal role. Despite the emergence, since its completion, of concerns about the importance of more comprehensive analysis of such projects there is still no evidence that economic efficiency is addressed by the PFRA in project selection.

A continuing federal involvement in water supply projects on this basis seems to be inconsistent with stated policy - in particular those aspects that call for use of water for the greatest social and economic benefit of Canadians (Environment Canada), and for the agri-food sector to make a real contribution to the Canadian economy (Agriculture Canada). It is assumed that efficient resource use and allocation is an essential condition in achieving these objectives and contributing to social and economic benefits or making a "real" contribution to the economy.

Nor does there seem to be a commitment to the federal environmental assessment and review process, which might ensure that the full range of impacts would be considered in major project analyses. These kinds of tests are sorely needed, perhaps particularly for the PFRA, an agency whose original goals of rehabilitating the drought and soil drifting areas of the Prairies have surely been met, after almost fifty years.

Consistency

A frequent criticism of federal water policy is that various programs are working at cross purposes. This can be illustrated with reference to drainage and reclamation projects. While many of these are economically efficient in their own right (2), questions raised about them generally point to the fact that different federal agencies are pursuing, independently, conflicting goals.

Thus it is pointed out that while the Canadian Wildlife Service works to protect wetlands, PFRA and Agriculture Canada are involved in support of drainage and reclamation projects. And the rationale of drainage and reclamation projects is further questioned insofar as some suggest that they may accelerate runoff and peak flows, in contravention of efforts by Environment Canada in flood control and damage prevention.

While there may at first glance appear to be contradictions in these programs, closer scrutiny shows that is not always the case. In terms of the preservation of wetlands for wildlife habitat versus drainage for agriculture, it may be entirely consistent to support drainage of some wetlands and preservation of others. The appropriate use of any individual wetland will depend on the respective costs and benefits in each use, and it would hardly be expected that analyses would indicate that all wetlands should be preserved, or that all should be drained. Thus while these policies may appear inconsistent, they may very well not be. The issue, it would seem, is whether there is careful analysis of the impacts on and values from alternative land and water uses before decisions are made to support drainage, or preserve wetlands. This is something that would have to be done on a case by case basis, and we can see no evidence of this in the federal approach to these programs.

Circumstances are much the same when looking at the apparent conflict between drainage and control and prevention of damage from flooding. As noted previously, such conflicts may be more apparent than real real. Some kinds of drainage projects actually help to reduce peak runoff, while others may increase peak flows. A consistent federal policy depends again on assessment of the respective magnitude of costs and benefits associated with the program actions. The costs of realizing benefits from a particular drainage project may include the incremental costs which drainage adds to flood control in the watershed. Whether the drainage project should be undertaken, given those additional costs, depends on whether the benefits are great enough to compensate for them. If they are, it is clearly more efficient to proceed and accept the costs, rather than forego the benefits from drainage. The issue, again, is whether project analyses take the full range of costs and benefits into account - and again there is no evidence of a commitment to do this.

Finally, the objectives stated for Environment Canada call for users to pay the costs of using water. As the question of paying for water supply projects has been addressed, however, it has become obvious that agriculture cannot pay, directly, more than a small portion of total project costs. (Though the charges actually levied are generally lower than the ability to pay, even were the charges equal to the full ability to pay they would still fall far short of costs.) This has led to the evolution of cost- sharing formulae, where the majority of costs are borne by governments who are taken to represent non-farm beneficiaries of the projects. There appears to be a genuine inconsistency here, in relation to further federal participation in water supply projects.

Summary

The broad federal policy objectives relating to water use in agriculture are found to be laudable and generally consistent. The actual programs which are "delivered" under the auspices of these policies do not, however, necessarily conform. The divergences or discrepancies do not arise because what is done can be rejected out-of-hand as being inconsistent with policy objectives. (A major PFRA sponsored project, to supply water for irrigation for example, may or may not represent an efficient use of resources.) They arise because programs, and projects within those programs, are not assessed or tested in a rigorous fashion to see if they do comply.

Our major concerns, therefore, are with implementation. Programs and projects are not being tested to determine whether they represent "use of water resources for the greatest social and economic benefit of Canadians", or make a "maximum real contribution to the national economy". Nor are they being tested for internal consistency, although appropriate attention to the question of efficient resource use would implicitly address this concern.

5. RECOMMENDED CHANGES IN FEDERAL POLICIES AND PROGRAMS TO IMPROVE THE SOCIAL, ECONOMIC AND ENVIRONMENTAL CONTRIBUTION OF CANADIAN AGRICULTURE

Our critique does not fault a number of federal programs and policies affecting agriculture and the related use of water. These include research, soil and water conservation, extension and dissemination of technology and management information, and resource planning. All of these functions attempt to improve the social, economic and environmental contribution of Canadian agriculture. There may be grounds for questioning federal participation in some of these programs, but on efficiency grounds at least their goals are certainly worth pursuing.

In other areas, primarily those with a strong project orientation, we are not recommending that policies and programs be abandoned. The concerns are rather that implementation does not appear to be consistent with broad policy guidelines, and with a lack of commitment to rigorous testing and analysis of projects prior to endorsement or participation. In particular the federal role in large water supply projects and in drainage and land development programs is singled out for criticism.

It is to the implementation process involving projects of these types that we address the following recommendations for change.

Water Supply Projects

The federal government, through various agents, in particular the PFRA, has in the past made major contributions to large irrigation water supply projects. It is not clear that in doing so the federal actions have conformed to the presently stated policy regarding water resource developments. It is understood that conditions were very different when those commitments were made, however, with several important factors distinguishing them from the present. In particular, many of the projects were directed at providing relief from the drought which had ravaged the Prairies and, as the projects involved the first large commitments of river flows, the availability of adequate water for irrigation and other uses was not a concern. It is not surprising that against that background many of the projects, which have brought about dramatic changes in agriculture in many areas, are viewed as highly successful.

The purpose here is not to criticize past projects. Rather it is to note that circumstances are now markedly different from those which prevailed at the time that they were undertaken, and that the same approach to federal involvement may no longer be appropriate. Perhaps the major distinguishing feature is that at present substantial portions of available water supplies are already committed, water is no longer abundant relative to demands, and its continuing availability to potential users on a first come-first served basis is very much an issue.

Before additional water supplies are committed to agriculture there is clearly a need to examine if this will maximize the social and economic benefits from the water resource, relative to other potential uses. There is also a concern over the terms of commitments in water use - with the need to maintain a margin of flexibility in order to cope with future, unforeseen demands from alternative uses.

The provinces, with legal jurisdiction over water, have in the past been willing to allocate it for agricultural use without levying a charge for the water per se. Not only has the water been provided at no direct charge, the fees that have been levied have consistently failed to cover even the cost of the labor and capital required to deliver it. The federal government, as a cost-sharing partner in some of these undertakings, and the sole developer in others, has provided financing to recruit the labor and capital for project construction. The result has been a policy of cheap water for agriculture.

From the evidence which is available, it is not clear that past projects would have passed the tests of comprehensive benefit cost analyses. Nor is it clear that future projects will - particularly in view of the fact that most of the least expensive sources of water have already been developed. It would be unwise to recommend rejection of federal participation in future projects out of hand, however. A more appropriate response is that a clear demonstration that the projects will in fact make a net contribution to the economy should be a prerequisite to federal cost-sharing.

Recognizing that we are in an era where the availability of water can no longer be taken for granted, where alternative uses may be as or more highly valued than agriculture, and where the full range of effects on other water users should be taken into account, federal contributions to major water supply projects should be contingent on rigorous analyses. The Treasury Board's benefit cost guidelines (48) lay out the basis for evaluation of federal programs in terms of the national economic efficiency objective - and these should be applied to federal involvement in water supply projects for agriculture. These guidelines are being applied to an ever-widening range of federal investments; failing to apply them to agricultural water supply projects may result in the wasteful allocation of federal financial resources.

In making this recommendation it is noted that these guidelines have already been applied to flood control programs in which the federal government participates, and are rigorously applied to other programs, such as the Salmonid Enhancement Program on the Pacific coast. What is required is development of a consistent approach to evaluation of the various programs in which there is a federal involvement in water supply for agriculture. Such evaluations should take into account alternatives for meeting a given goal (structural and non-structural), should take full account of the effects on, and

values in, other water uses (present and future), and should attempt to fully account for "environmental" effects to the extent that they are not encompassed in the consideration of other water uses.

It is difficult to predict what the results of individual project analyses would be if they were carried out on this comprehensive basis. (It would be particularly interesting and instructive if retrospective project evaluations could be completed, as these could shed considerable light on the reasonableness of predictions being used in prospective project evaluations.) But it would not be at all surprising if many projects did not pass the "test" with respect to national economic efficiency. This in turn would bring into question the appropriateness of federal participation in the projects.

It is recognized that there will be strong pressure for continued federal cost-sharing of projects from local and regional interests (43) who stand to benefit from the continued availability of cheap water for agriculture. And it is expected that the provinces may be willing to continue to make the water itself available for use in agriculture at little or no cost. On the other hand, it is clearly time to recognize that serious problems will emerge if policies are pursued which attempt to keep water cheap when it is not. Continuing with a cheap water policy will only encourage its continued inefficient use, thereby intensifying the eventual pressures for re-allocation and limiting the long-term role of irrigation (20).

Drainage and Land Development Projects

These types of projects do not necessarily involve the direct use of water in agriculture, but they can have significant effects on the distribution of water and its availability for non-agricultural uses. At present the effects on other resource uses, or interactions with other programs, are not consistently taken into account before projects are undertaken, and there is apparently no requirement that this be done.

The concerns identified over federal involvement in such programs lie with the apparent (though not necessarily real) inconsistencies and conflicts between various federal programs. Addressing these concerns does not require that federal participation in all such projects be suspended. What it does require, as with water supply projects, is the application of rigorous project analysis which would ensure that the full range of project impacts is taken into account. A benefit-cost analysis consistent with the Treasury Board Guidelines would appear to be appropriate, with specific attention paid to both positive and negative effects on other uses of water.

Again, as with water supply projects, it is not expected that all projects would pass the economic efficiency test implied in such analyses. The consequent prospect is that federal

participation in such programs would be reduced in future. In the case of drainage projects, in particular, the point is repeatedly made that large areas of wetlands have already been eliminated, with loss of other resource values. This increases the importance attached to remaining wetlands, and in view of that it would not be surprising if analyses indicated that it was appropriate to slow the rate of conversion of wetlands to other uses. Such a position by the federal government might well be opposed by those who would benefit from continued drainage and agricultural expansion. On the other hand it would have to be seen as recognizing the wider range of federal interests and responsibilities.

Standards for Project and Program Evaluation

Several briefs to the Inquiry have stressed the need for better techniques to evaluate projects and priorities in water use (2, 9, 10, 18). And it has been suggested that a federal strategic plan is necessary to guide federal agency programs which deal with water resources (18). Central to these recommendations, as with ours above, is the need to adopt consistent evaluation procedures.

It is instructive to note that a similar need was recognized several decades ago in the United States, where federal involvement in water resource projects was very widespread. In 1965 the Water Resources Planning Act established a U.S. Water Resources Council to coordinate the activities of the various federal agencies dealing with water resources. The Council was charged to establish principles, standards and procedures for federal participants in the preparation of comprehensive regional or river basin plans and for the formulation and evaluation of federal water and related land resources projects (24). This led eventually to the 1980 "Principles and Standards for Water and Related Land Resources Planning" (49). While the subject of some criticism, it is generally acknowledged that these standards have greatly improved the approach to federal participation in water resources projects, broadened the range of project effects which are routinely considered, and made explicit the tradeoffs between different objectives.

It may be beyond the scope of our inquiry and recommendations, but it does appear, given the wide range of federal policies and programs that impinge on agricultural development alone, that a similar approach to establishing consistent standards and procedures for federal participation in water resources development in Canada should be investigated.

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STUDY TERMS OF REFERENCE

Objective:

The objective of the report is to explore the role of water in current and projected Canadian agricultural development and the impacts which agricultural demands are likely to have on the quantity and quality of waters available to other uses.

Tasks:

The contractor hereby agrees to:

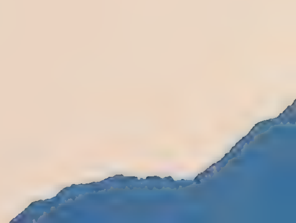
1. Review agricultural acreage and yields projections and analyze their implications for the use of water nationally and regionally;

2. Analyze the capability of agricultural producers to pay for water-related services (e.g. irrigation, drainage projects) in relation to other water users;

3. Analyze various adverse impacts (erosion, salinization, contamination, flow depletion) which agricultural expansion is likely to have on other uses of the resource, and means of reducing these impacts;

4. Document and critique (federal) policies and programs which influence agricultural demands for water;

5. Recommend changes in federal policies/programs as appropriate to improve the social, economic and environmental contributions of Canadian agriculture.



Inquiry on Federal Water Policy

Enquête sur la politique fédérale relative aux eaux

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FEBRUARY 1985

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Inquiry on Federal Water Policy
Research Paper #19

RISK MANAGEMENT WORKSHOP
FEBRUARY 1985

by

Carolyn T. Miller

Environmental Protection Service
Environment Canada
Hull

June, 1985

THE INQUIRY ON FEDERAL WATER POLICY

The Inquiry on Federal Water Policy was appointed by the federal Minister of the Environment in January of 1984 under the authority of the Canada Water Act. The members were Peter H. Pearse, chairman; Françoise Bertrand, member; and James W. MacLaren, member. The Inquiry was required by its terms of reference to review matters of water policy and management within federal jurisdiction and to make recommendations.

This document is one of a series of research papers commissioned by the Inquiry to advance its investigation. The views and conclusions expressed in the research papers are those of the authors. Copies of research papers and information on the series may be obtained by writing to the Enquiry Centre, Environment Canada, Ottawa, Ontario K1A 0H3.

Frank Quinn
Director of Research

Abstract

This paper includes a brief overview of the nature of risk management as well as the results of a workshop on the subject held in February 1985.

Suggestions are made in order to better define the structure of decision processes, the risk management policies and the federal/provincial roles in risk management and to improve the legitimacy of risk management decisions.

Résumé

Ce rapport présente un bref aperçu de ce qu'est la gestion des risques de même que les résultats d'un atelier de travail sur le sujet qui a eu lieu en février 1985.

Des suggestions visant à mieux définir les structures du processus décisionnel, les politiques de gestion des risques et le rôle des gouvernements provinciaux et fédéral dans ce domaine et à améliorer la ligitimité des décisions prises sont présentées.

INQUIRY ON FEDERAL WATER POLICY
RISK MANAGEMENT WORKSHOP

Carolyn T. Miller, Ph.D

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Summary

In 1984 the Minister of the Environment established a Commission under the chairmanship of Dr. Peter Pearse to explore and make recommendations on issues of water policy and management within federal jurisdiction. A workshop on risk management was convened as one element of the Inquiry.

The Commission invited the participants at the workshop to provide advice on:

- how decision-making processes should be structured when significant uncertainty exists;
- how policies to guide natural resource management should be adapted to cope with uncertainty;
- how federal and provincial roles could be united into a workable partnership;
- how public policies for risk management could be made more legitimate.

"Risk management" involves analysing the consequences of the various options for on-going or proposed human activities, and deciding on adjustments that are in the public interest. The term generally implies that the choice of a course of action is based on a structured analysis of risks and benefits, and the fairness of their distribution. In the approach adopted at the Workshop, not only scientific analysis but also more intuitive perceptions and judgements play essential roles in decision-making. Stakeholders, publics, expert advisors and authorities work in concert to decide upon and implement a course of action.

Decisions influencing the management of water resources are made in the context of a dynamic environment in which human activities and natural phenomena interact. Assessing and controlling the impact of the industrial age on the overall integrity of the environment is a formidable challenge — a challenge to the powers of reason. Mankind can observe, evaluate and begin to understand the biosphere. In the light of this understanding, human activities can be deliberately modified to promote sustainable economic and social development.

Three different reasoning processes could be isolated, each contributing a new dimension to the understanding of man/environment interactions. First, the scientific process employs iterative observation, deduction, induction and hypothetical prediction to gain understanding of the laws of nature, the condition of the biosphere and predictions for the future. The second process, the process of public/market choice, has a significant intuitive element. In this type of rationality, individuals or groups with interests in common muster whatever powers of persuasion they can in support of their interests. The preferences of dominant coalitions emerge as a set of value judgements.

The third reasoning process must place the interests of society as a whole above the interests of individuals or groups. These three kinds of reasoning together determine appropriate interventions.

A general framework for the analysis of decisions in the public interest has emerged simultaneously from several fields. It incorporates all three rationalities and deals with the following bodies of information:

- human needs and wants;
- the stakeholders, experts and authorities involved;
- the weights of influence of the players;
- intervention options (actions and incentives);
- predicted positive and negative consequences of options;
- perceptions of the value/importance of consequences;
- sensitivity of the consequences to uncertainty.

The discussions at the workshop generated the following conclusions:

Decision Processes

- The ingenuity needed to improve the quality of life arises from three reasoning processes: scientific assessment, public/market choice, and the political inference that places the interests of society above the interests of particular publics. Decision-making should draw upon all of these forms of reason.

- A clearly identified authority should be responsible and accountable for ensuring that decisions are made, implemented and evaluated. Procedures for appeal should be spelled out.

- The decision process should have the capacity to make judgements on urgent issues and take prompt action.

Risk Management Policies

- Policies to guide interventions in human activities should recognize the equal right of all Canadians to environmental quality, and recognize the need to maintain essential ecological processes and life support systems.

- When uncertainty is high, public policies for risk management should (1) define the "due process" for decision-making as well as (2) provide guidance for resolving specific cases.

- Both the guiding policies and individual risk management decisions should consider the consensus developed through consultation with stakeholders and expert advisors.

Improving the Legitimacy of Risk Management Decisions

- Institutional arrangements are needed to negotiate a consensus, at both scientific and public levels, on priorities for social action.

- Improved measures of the health of ecosystems are needed.

- Improved communications between governments, stakeholders, experts and the public are needed.

- Legitimate environmental stewardship will require a deep-rooted social commitment to sustainable development. This social commitment should be supported by improved methods of risk perception and the resolution of conflicting perceptions; educational programs to display the interactions between human activities and natural phenomena; and school curricula to develop better understanding of risk, uncertainty and probability.

- Trust and respect for public policies will require the greatest possible openness and the full display of the elements of decision-making.

Overall, risk management provides a useful tool for organizing and displaying the information involved in public policy decisions. The framework accomodates disparate value judgements with respect to the importance of changes in the various social, economic and environmental factors at risk. Predictions are made about both the consequences and legitimacy of management strategies, and finally, uncertainties can be converted into guidance for further consultation, research and intervention.

INQUIRY ON FEDERAL WATER POLICY RISK MANAGEMENT WORKSHOP REPORT

Carolyn T. Miller, PhD.

History

In 1984 the Minister of the Environment established a Commission under the chairmanship of Dr. Peter Pearse to explore and make recommendations on issues of water policy and management within federal jurisdiction. The resulting Inquiry included public hearings across the country, as well as a wide-ranging set of research projects and workshops.

At the Risk Management Workshop, held February 20-22, 1985 at Strathmere House, specialists in the areas of economic analysis, perception of public values, ecotoxicology, scientific risk assessment and government infrastructure met with members of the Commission to debate short background papers and exchange perspectives on problems of risk management.

Commissioner Pearse opened the Workshop with two premises. First, he observed that polices to guide the management of water resources must recognize risk, uncertainty and unforeseeable change. Second, he concluded from his experiences during the public hearings that any process which fails to clearly allocate responsibilities and depends entirely on cooperation and good will is unrealiable.

The Commission challenged the workshop with providing advice on:

- how decision-making processes should be structured when significant uncertainty exists;
- how policies to guide resource management should be adapted to cope with uncertainty;
- how federal and provincial roles could be united into a workable partnership;
- how public policies for risk management could be made more legitimate.

Background

"Risk Management", taken literally, means controlling the chances of bad consequences. In practice, the term generally implies that the management strategy is based on a structured analysis of risks and benefits and the fairness of their distribution. To some, however, the meaning is more restricted. They maintain that only objective, scientific analysis should be involved in public policy decisions. Perceptions, feelings and public opinions are left out. In the approach taken at the Workshop, all reasoning processes were considered to be not only admissible, but essential.

A risk manager, for example, might look into the question of diverting water from its natural lake system to help reduce drought somewhere else. The risk

management process would look into the future, and figure out what is likely to happen if 10% of the water is diverted, 1% is diverted or none is diverted. The benefits of diversion to the drought-stricken area would be balanced against the benefits being derived from leaving some, most or all of the water in its natural location. Similarly, the risks of diverting or not diverting would be predicted for both areas. The decisions as to what to do would represent a trade-off taking into account the consequences (good and bad), how likely those consequences are, and how to make the distribution of the risks and benefits reasonable and fair.

Such risk management decisions are never easy. Different people attach a different level of importance to such things as agricultural profits, recreation potential and uncertainty about the long-term stability of ecological systems. It may be virtually impossible to please everyone. Lakefront property owners would howl if they thought their scenic view might become a 5 metre zone of sludge and slime, as a result of water diversion.

Further, it is rarely possible to predict precisely what will happen since scientific understanding of complex ecosystems is just beginning to develop. Often the trade-off must grapple with the possibility of a very serious consequence without much knowledge of how likely that consequence is.

Feasibility must be considered. Is it technically possible to divert the water? Costs must be considered. How much would the technology, engineering, maintenance and manning of a water diversion system cost? Would the increased crop yield pay for it?

Market conditions have to be considered. Would there always be a buyer for the diverted water? Who would pay for the diversion system in non-drought years? How often does a drought occur?

Even when a careful analysis has been made, and the preferred course of action has been decided, there still remains the problem of getting people to behave the way the decision-maker thinks they should. If it is decided that no more than 1% of the water should be diverted, what incentives can be arranged to reduce the temptation to take 5% when the drought is at its worst and the price paid for water is high? What arrangements could be made to ensure that the operators of the diversion system are accountable not only to their shareholders but also to both the buyers and the community whose natural ecosystem is being drained? Finding workable incentives, to make all of the players want to accept and honour the decision is one of the major challenges to the ingenuity of risk managers.

At the heart of "risk management" is the decision analysis that draws on the knowledge developed through scientific, social and economic assessment, and then balances different perceptions of the importance of the likely consequences. This analysis helps the authorities to choose a course of action that is in the best interests of society as a whole. Risk management is the combination of analysis, judgement and behaviour modification needed to achieve political, social, economic and environmental goals in an efficient, effective and equitable manner.

Objectives

The Risk Management Workshop addressed the problems of deciding on interventions that are cost-effective, widely accepted, and fair. (See Annex 1.) It was not the purpose of the Workshop to resolve specific issues such as whether to divert water, or whether to reduce the release of chemicals into the environment.

It was not the purpose of this workshop to explore the "how to" of risk assessment. Risk assessment is the task of experts from a wide range of disciplines - chemistry, biology, ecology, mathematics, toxicology, epidemiology, economics, sociology. The best available analytical tools are used to predict the consequences of each possible course of action and estimate how likely those consequences are. Rather, the workshop debated ways to use the results of risk assessment to assist with two kinds of decisions: which problems to tackle first, and then, for the priorities, what to do about them.

The Risk Management approach to decision-making does not make the decision for you. What it does is provide a framework - a guide to the kinds of information, consultation and reasoning needed to support the decision.

A Framework for Risk Management

The field of normative economics has provided a general approach for the analysis of strategies for social intervention. The Workshop reviewed the elements of "multi-attribute utility theory" in the form of a hypothetical case study of the analysis of water management options. A description of the quantitative application of the approach is provided in Annex 2. A qualitative overview is presented here.

Information Needs

Although the terminology used may differ somewhat in different sectors, most risk management frameworks are based on the same kinds of information.

1. **The People**

   The decision analyst needs to know who the decision authorities are. Who has the power to make, implement and evaluate the decision? Who do you go to, to appeal? Who administers the decision process? Who are the experts capable of bringing the tools and knowledge of the appropriate natural and social sciences? Who are the stakeholders - the publics that stand to benefit (or suffer) from the consequences of the decision?

2. **Desired Results (Objectives)**

   The analyst needs to know what it is that people need and want. Generally, these desired results are expressed in terms of the social, economic and natural aspects of the environment that people would like to achieve. For example, a social aspect could involve the level of government intrusion into

human activities; an economic aspect could be the return on investment in a water diversion facility; and important aspects of the natural environment could include the stability and aesthetic quality of lakefront property, and the agricultural productivity of a geographic region.

3. Measures of Achievement

Once the objectives "at risk" and subject to change because of the decision have been identified, the next challenge is to find ways to measure (or predict) the degree of achievement that has been (or might be) attained. Level of government intrusion might be measured as hours spent by stakeholders interacting with government officials; return on investment could be measured as percent recovered per month; stability of lakefront could be measured as the probability of a water level of more than 1 foot below seasonal norms and aesthetic quality could be measured as a change in the number and type of plant species.

4. Intervention Options (Actions and Incentives)

Having identified a problem - a source of dissatisfaction - such as poor agricultural yield due to recurring drought in a certain area, the analyst needs to know what the options for addressing the problem are. Various water diversion techniques, local water management, a shift to drought-resistant crops, or use of fast-maturing varieties could all be considered. In fact, lining up the options is sometimes the most open-ended component of the risk management process. There may always be another possibility, or combination that you haven't thought about!

For toxic chemicals, the selection of feasible intervention options requires analysis, in consultation with technical experts, of every stage of the chemical life cycle. Opportunities to break the chain of cause and effect may occur during research and development, manufacture, registration, transport, use or waste disposal.

In addition to lining up the options for preventive action, it is necessary to consider the feasibility of persuading people to modify their behaviour. In the water diversion example, it may be that a shift in the choice of crops would be best in the long run. But people get set in their ways and resist change. The analyst needs to know what incentives could be arranged, and whether the farmers in question would be likely to make the shift. Some examples of the range of available incentives are:

- process: jawboning, mediation, committees, consultations, adjudications, etc.
- regulatory: approved voluntary abatement, negotiated orders, permits, approvals, regulations, orders and injunctions

- civil liability and insurance
- regulatory economics: compensation funds, cleanup funds, emission charges, disposal pricing, marketable pollution rights, raw material pricing, delays, bonds
- fiscal support: tax deductions, rebates, credits, exemptions, equity/debt financing, government contributions, forgiveable loans, government loans, guarantees or insurance
- economic support: labour assistance, R&D support, export promotion

5. Predicted Consequences

For each intervention option, the consequences (good and bad) for each of the direct stakeholders and other publics must be predicted, using the objectives and measures of achievement already discussed. Very few predictions can be made with certainty and consequences often have to be expressed in terms of both the nature of the effect and the probability that it will occur.

6. Weight of Evidence

Expert judgement and consensus are needed to assess how good the predictions really are. Quality assurance indicators for the overall strength of the case, and for the range in which best estimates fall should be displayed.

These six kinds of information provide the basis for risk assessment - estimating the likely consequences of intervention options. Social, economic, environmental and human factors are all involved, and coordinated effort by experts from a range of disciplines from engineering to psychology is required. By assembling this information the analyst can clearly display the risks and benefits, who it is that will enjoy or endure them, and how strong the scientific case really is.

Risk assessment is the result of scientific reasoning - objective, dispassionate estimation of consequences. But decision-making requires more than just knowing the facts. Value judgements are required. The decision-maker must have significant understanding of how people perceive the importance of the various objectives.

7. Perceived Significance of the Consequences

Different stakeholders will perceive the importance of the objectives differently. To farmers, a water-shortage means disaster and the aesthetics of the lakefront seems relatively unimportant. To others, the reverse may be true. It is not a question of proving who is right or wrong. Each is entitled to his considered opinion. Such individual value judgements are reached intuitively. These in turn are subjected to debate and modification as each

stakeholder uses the powers of persuasion to influence others, until, by this ongoing process of "public choice" a consensus is reached.

Formal, quantitative application of multi-attribute utility theory assumes that measures of the consequences can be "scaled" - placed in order of increasing degree of significance. For example, for threats to long-term stability of a lakefront ecosystem, a score of 100 could be assigned if no threat was perceived. Zero could be assigned for substantial irreversible changes in 50% of the lakefront in regions with over 150 persons per square kilometer. Intermediate scores would be assigned to lesser degrees of damage. Clearly the valuation criteria are of paramount importance! A significant consensus-building process would be required to arrive at an acceptable "scale".

Further, quantitative application of the theory assumes that the scale of consequences for one factor (eg. ecosystem stability) is comparable to the scale for another (eg. health). That is, a score of "75" on both scales would mean that people would have great difficulty in choosing between them. These two consequences would be regarded as equally acceptable.

When the different consequences can be expressed in the same units - dollars for example - comparisons are fairly straightforward. The costs of a water diversion facility can be compared to the profits from agricultral productivity. But environmental results such as shifts in the type and number of species resulting from a change in water level are often uncertain, and far removed into the future. Studies show that people tend to discount future events heavily. On the other hand, uncertainty often leads to heightened levels of concern. Despite these problems people do make risk/benefit judgements all the time. "Should we go swimming on this beautiful beach even though the lifeguard has gone home?"

Even more difficult are quantitative procedures for comparing different objectives such as convenience or profit versus health. If using a pesticide runs a 10% chance of doubling the forest yield over 10 years, what risk should we take in terms of years of life lost or reduced health status for exposed people? For all the difficulty of making such judgements, people do make them. "Should I squeeze through this yellow light, or wait another cycle of the traffic signals?" For decisions with widespread social impact, a consensus on the relative importance of competing consequences is needed. This requires the participation of the direct stakeholders and other publics involved. The sociological tools for resolving different public perceptions have just begun to develop (see Annex 3).

8. Weight of Each Stakeholder

The decision analyst should attempt to find out how strong an influence each stakeholder is likely to have on the choice of activities, in the absence of any intervention by the authorities. This may be a very complex question, but it will shed a lot of light on how popular and widely accepted the management decision will be. In the end, the decision authority will have to make a judgement about whether the spontaneous influence of particular stakeholders

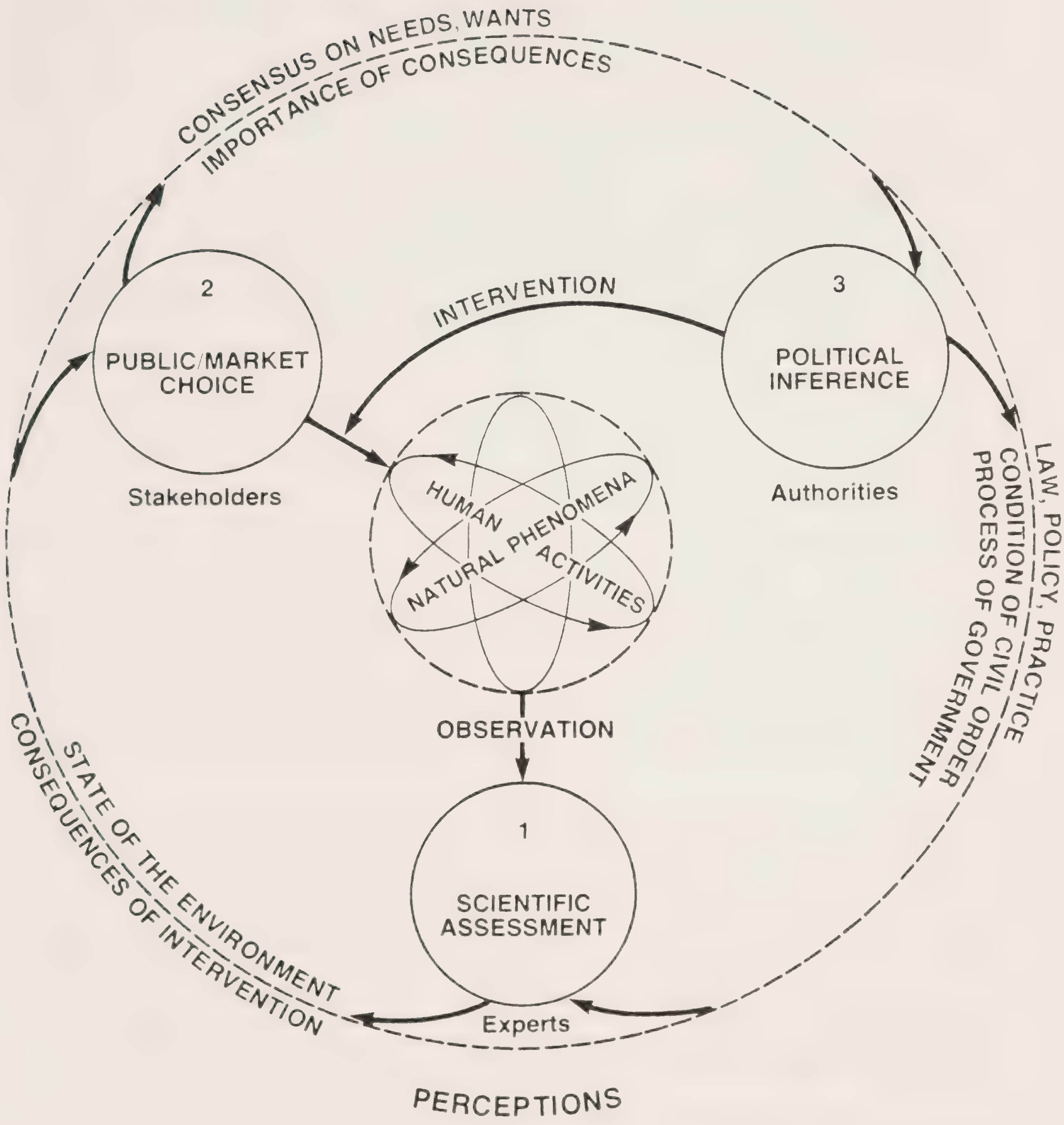


FIGURE 1 THREE RATIONALITIES: PARTNERS IN DECISION-MAKING

is what it ought to be. If not, then some form of intervention may have to be taken on behalf of society.

One way to adjust the weight that stakeholders have is to alter the membership of advisory groups. The access that a stakeholder has to the decision authority may determine the degree of influence.

9. Ethical Principles

In the final analysis, the decision authority must shoulder the burden of responsibility for deciding what is just. In making this political inference, ethical principles embodied in law, policy, practice and precedent will provide guidance. But in the end, the decision-maker (or each member of the "jury" if the decision authority is a group) must face the lonely challenge: "Make up your mind".

This body of information provides the basis for the risk management approach to decision-making. In figure 1, these elements are linked together by the intellectual processes that generate, communicate and use the information.

Three Human Rationalities: Partners in Decision Making (Figure 1)

Decisions influencing the management of water resources are made in the context of a dynamic environment. Human activities are changing; social customs, needs and wants are in a state of flux; and all of the physical, chemical and biological elements of the biosphere are influencing each other in a manner often too complex to comprehend. Nonetheless, for all its dynamic complexity, the biosphere has sustained an overall integrity throughout the geological history of life. Assessing and controlling the impact of the "new" human activities of our industrial age on this integrity is a formidable challenge.

As the impact of human activities becomes greater it becomes more and more important to have a valid perception of the nature of the biosphere and the role of mankind in it (see Annex 4). Three reasoning processes can be isolated, each contributing to human perception of the biosphere. The scientific method employs iterative observation, deduction, induction and hypothetical prediction to gain understanding of the laws of nature, the condition of the biosphere, and predictions for the future (See Annex 5 and 6). This objective scientific analysis is conducted mainly by specially trained experts. Unfortunately, scientists have a tendancy to communicate with each other rather than with the public at large. Often the "media" are called upon to function, not as a vehicle for transmission as the name implies, but as surrogate thinkers, and the message may get distorted. Scientists need to work harder at sharing their knowledge.

Within society, individuals or groups with interests in common engage in a different reasoning process, in which each public uses whatever powers of persuasion it can muster to gain support. This process of public/market choice has a significant intuitive element, and the preferences that emerge may not be consistent with the scientific assessment. However, this public choice rationality incorporates important judgements of the value of intangibles that are not readily amenable to current scientific analysis. It is encouraging that specialists in public perception and the more intuitive

processes for making value judgements are regaining a place for the social sciences in decision analysis. Without the insights derived from the social sciences public/market choices would remain a black box - something to be accepted without understanding. (See Annex 3).

While public choice and scientific analysis (natural and social) give rise to the aspirations and preferences of individuals or groups, a third rationality is required. "Political inference" must place the interests of society as a whole above the interests of particular publics. Politicians and bureaucrats generally have the greatest opportunity to apply this type of thinking. In our society specialists who have dedicated themselves to ethical philosophy (religious leaders, academic philosophers) generally must find ways to influence individuals, and through these individuals influence public choice. Our society often deliberately excludes ethical philosophers from any direct role in political decision-making!

Neither the bureaucrat, nor the elected representative, however, is a completely neutral broker. Officials are still people(!) and they will have their own consensus, determined at any point in time by the forces in their environment. Access to officials is therefore very important.

Whoever the decision makers are, their mental processes for political inference must gather in the perceptions resulting from scientific assessment and public/market choice and combine these with the standards of behaviour implicit in laws, policies, precedent and practice. The conclusions reached will determine the condition of civil order, the process of civil government, and the interventions imposed on public/market choice for the greater good of society.

If risk management is to be successful in assessing and controlling human activities so that essential ecological processes and life support systems are sustained, these three rationalities must be recognized and applied. The Risk Management approach accomodates all three of these reasoning processes.

Annex 4 describes "a widespread intellectual error in the conceptualization of the environment-society relationship". It proposes that many people in government, economics and public affairs conduct themselves as if the environment were "an element in the context of human affairs" - something to be exploited rather than nurtured. Yet, it proposes that these same people would probably claim to support the reverse perspective: "human affairs are an element in the context of the environent". --- "When we look at the heavens and back at ourselves, we take our place --- within an encompassing environment".

Generally, participants did indeed support this second perspective. However, most also felt that the concept of management implicit in this document is one of nurture, and is consistent with "our situation as active participants in the biosphere". The reader is invited to make an independent judgement!

Roles in Risk Management (Figure 2)

Stage 1 - Consensus on Priorities

The first stage of decision-making for risk management involves consultation to identify problems and set priorities. This consultation may occur spontaneously as a result of interacting social or market forces and the sensitivity of politicians and bureaucrats to public pressures. Alternatively, the process may take place in a more structured way under the guidance of government. Whether spontaneous or deliberately structured, stakeholders and publics provide their perceptions of the condition they are and would like to be in, and scientists supply their estimation of the present and future condition of society/environment. Through consultation a consensus is reached as to which objectives are most important and which are not being met. Guidelines could be established to indicate what measurable level of environmental quality is desired.

Within government, line departments should be responsible for establishing communication avenues to draw in scientific (social and natural) assessments and public/market choices. If publics do not know that priorities are being negotiated, or do not know who to contact, or do not care enough to come forward, the range of participants may be biased, and the quality of all subsequent elements of the decision process will be jeopardized. The best system imaginable cannot do much if it is addressing the wrong problems.

Stage 2 - Decision Analysis

Once a consensus has been reached as to which social/environmental problems should be addressed, the decision analysis can proceed, using the classes of information and reasoning processes already discussed.

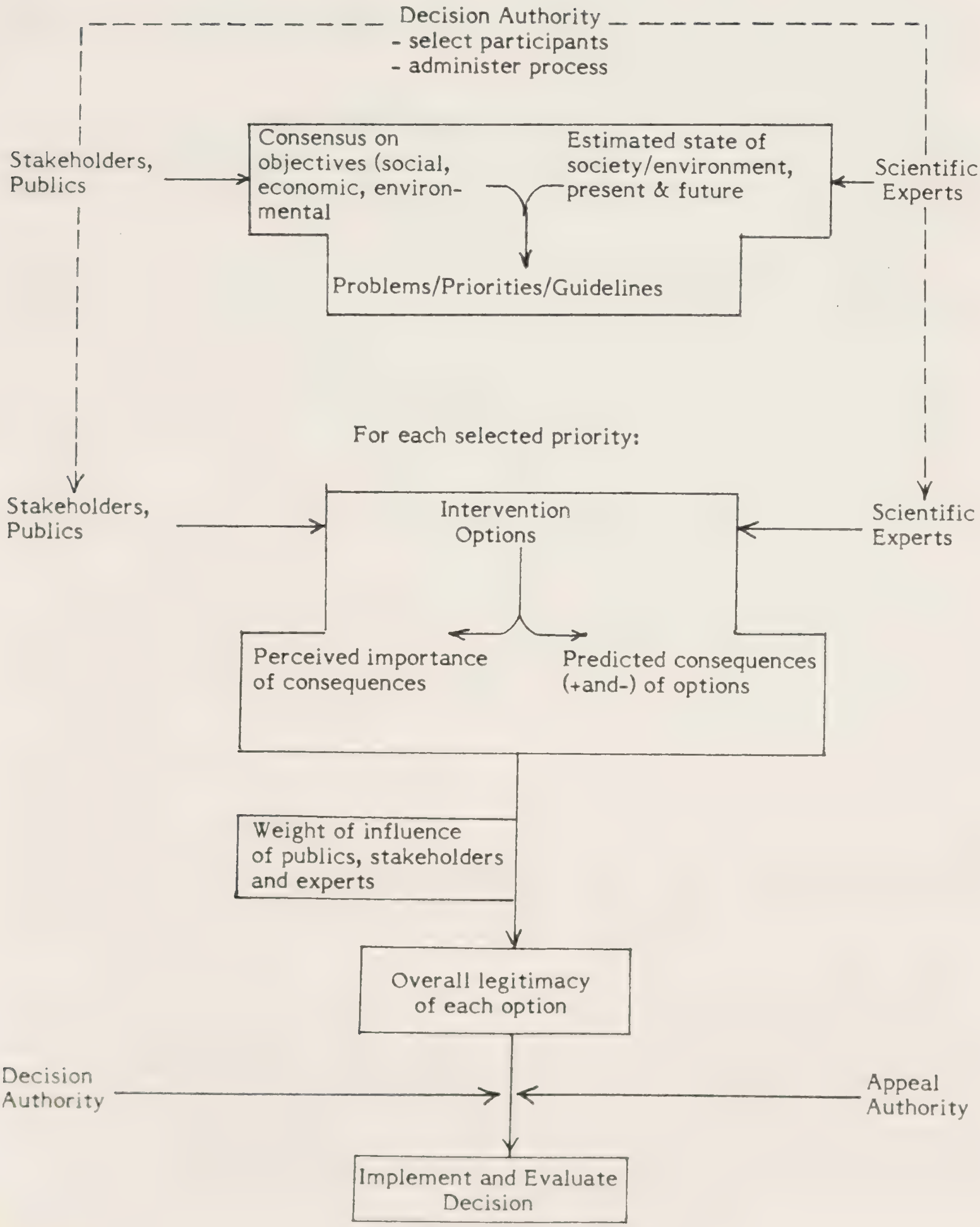
The multi-attribute utility framework describes a general procedure for decision analysis. However, by deletion of various elements it can easily be converted to more traditional approaches. For example, if all monetary attributes are combined into one number, and all non-monetary attributes similarly combined then the model reduces to cost-utility analysis like that frequently used in health care evaluation. If all consequences except one are valued in terms of dollars, the model becomes cost effectiveness analysis. If all consequences are given dollar values, the result is cost-benefit analysis. If only one option is considered (as in whether or not to register a specific use of a pesticide) and the positive and negative consequences (of pesticide use) are expressed in a common unit, the model becomes a "simple" risk/benefit analysis.

Stage 3 - Decide, Implement and Evaluate Social Action

The multi-attribute utility framework provides an analysis of the information available. It does not remove the necessity to have a clearly defined decision-maker. Some person or group must take the responsibility and decide. Most important, the decision maker should have the authority to ensure that action is taken and evaluated.

However, as a safeguard to ensure fairness, a clearly defined avenue of appeal should be available.

Figure 2: **Roles in Risk Management**



Uses of the Framework

This framework for the analysis of policy and intervention options does not make the decision for you. It can, however, contribute greatly to the efficiency, effectiveness and equity of the decision by displaying very clearly the players, the factors considered and the assumptions made.

The framework need not be used quantitatively. Indeed, participants at the Workshop felt that the quantification and scaling of estimates for environmental objectives is often beyond the capacity of current scientific techniques. However, qualitative assessments could be displayed in the same framework and achieve the needed clarity of analysis.

The multi-attribute utility framework has found three additional applications in practice. First, it has been constructively used as a consultative tool. The framework clearly identifies the dimensions of the decision: attributes at risk, constituencies participating, weights of influence, policy (intervention) options, predicted positive and negative consequences, perceptions of the importance of consequences and the sensitivity of the final outcome to uncertainty. By breaking the decision process down into these more manageable components, and building consensus on one element at a time, progress towards a legitimate solution is greatly facilitated.

Second, describing the decision process as a sequence of discrete steps provides the basis for sensitivity analysis. Steps where the range of uncertainty makes a critical difference to the final decision can be identified and researched further. In this manner the framework provides an objective approach to defining research needs and directing resources to the generation of the most crucial information.

Third, the intervention most likely to have the desired effect may be put in place first. After a delay sufficient to allow the intervention to take effect, re-assessment would then provide more accurate insight into the need for additional actions. Such step-wise management can be more efficient than attempting to solve all aspects of a complex problem at one time.

Overall the multi-attribute utility framework provides a useful tool for organizing and displaying the information involved in risk management. The framework accomodates disparate value judgements with respect to the importance of changes in the various social, economic and environmental factors at risk. Predictions are made about both the consequences and legitimacy of management strategies, and finally, uncertainties can be converted into guidance for further consultation, research and intervention.

Limitations of the Framework

The heavy demands for consultation, consensus-building and scientific prediction may be considered a drawback. In some situations much simpler analyses may suffice. However, when uncertainty is high science cannot substitute for consultation and the pooled wisdom of concerned constituencies. Further, if uncertainty is high, legal and regulatory approaches with specific punitive measures for defined behaviours are inappropriate. How can punishment be justified if the occurrence of the "crime" is uncertain?

This is not to suggest that regulation has no place in environmental management. A double-barreled approach can be effective. If an estimate of risk exceeds a critical level, regulations may be enforced. But within a lower range of possible risks, negotiation and consensus building could take over. (This approach has been used in Canada with respect to water & air quality objectives.)

Environmental quality guidelines may be used to trigger in-depth assessment and review. If meeting the guidelines imposes significant hardships, stakeholder negotiation and consensus-building could be used to find a legitimate solution. Broad national environmental legislation and policy is required to guide the resolution of disputes.

One limitation of consensus-building processes has been debated since the days of Plato. How can the integrity and objectivity of advisors be ensured, in the face of the oppoutunity to provide self-serving advice? If a toxicologist recommends a great deal more toxicological research, who is he serving? If industry recommends a solution that increases the immediate return on investment of shareholders, is the advice to be trusted? No absolute solution has emerged.

Openness of the decision-process and display of all the elements will make publics accountable in the eyes of their colleagues and peers. But if participating publics are selected on the basis of their social influence or the size of the "stake", the consensus that emerges is very likely to reinforce the status quo or even focus more sharply on the values of the powerful, without triggering negative peer pressure. More equitable solutions are likely to be found when community leaders, and publics who are not <u>direct</u> stakeholders have a strong voice in the consensus-building.

Consensus-building, like voting, is subject to deliberate "gaming" -misrepresentation to achieve winning coalitions. Playing upon human sensitivities and crowd appeal, or keeping information secret in order to cajole, embarrass or entrap people into a coalition is an old, and human, occupation. However, practitioners should be very cautious. Except for the very short term, openness and integrity have proven their worth!

Risk Management in the Canadian Setting

Scientific and Technical Input

The scientific approach involving iterative observation, induction and deduction, and hypothesis testing is commonly used as the starting point to estimate, understand and evaluate the conditon of society in the environment.

The scientific data base generally has two components, one resulting from "basic" studies of cause/effect relationships, and the second arising from specific studies designed to shed light on the particular problem at hand. However, some issues will be of immediate concern requiring urgent evaluation and action. Decisions will have to be made without the benefit of special research. The decision that the evidence is sufficient to warrant action is a political one with a significant intuitive component. This decision should remain the responsibility of elected representatives.

In any scientific analysis there are biases and uncertainties and the data should be presented in association with:

- the assumptions implicit in predictive models;
- sources and degrees of uncertainty.

It was considered imperative that scientific data be openly published to allow peer review and avoid the inevitable bias of closed communities. Time is required for dissemination, consultation and the resolution of different interpretations of the data sets. It might be efficient to establish a "science court" to formalize and accelerate the consensus-building process which contributes the scientific understanding needed to assist the resolution of a particular issue.

In many public policy decision processes, the scientific understanding becomes diluted and befogged as each layer of authority adds a new (intuitive) perspective. Scientists, perhaps because of their highly formalized rationality, find it difficult to communicate with publics and officials, and their particular insights and perspectives often either do not become a part of the overall decision at all, or reach the public after additional rounds of re-packaging by officials or the media. There is a real need to improve the public communication of science. The scientific community needs to lead itself out of isolation.

The Associate Committees of the National Research Council have attempted to provide a forum for the scientific input to priority setting. As a Crown Corporation, NRC operates at arm's length from the sectoral interests of any particular federal department. It had gained the confidence and respect of the scientific community and had both the in-house expertise and the external network to function effectively. These Committees were supported by a secretariat and a contract fund to establish scientific criteria for environmental quality. Unfortunately, this fund, along with its special secretariat have been cut. Workshop participants strongly recommend that the scientific consensus - building function be strengthened, and that much improved communications be developed with the line departments responsible for implementing interventions.

Values, Perception and Communication

The general framework for risk management (Figure 2) calls for the inclusion of risk perception whereby publics intuitively estimate, understand and evaluate the condition of society in the environment. The workshop participants agreed that opportunity for publics to make such input should be regarded as a fundamental right, accompanied by full disclosure of information in so far as legally possible. While a range of modes for public input (hearings, questionnaires, conferences, private interviews) has been tested out, the need to develop new ways to reconcile conflicting perceptions was identified.

Grass roots development of a better understanding of risk and uncertainty through a range of educational programs and school curricula was advocated. It was agreed that "stewardship" can only become effective when there is a genuine environmental ethos involving trust and partnership between government and publics. As a first step it is important to ensure that procedures and points of most effective public input are clearly defined and understood.

It was recognized that public consultation is itself expensive and that public debate of uncertain risks will generate a further social cost in the form of anxiety.

However, the Workshop agreed that public participation was fully justified by the benefits of confidence, security and sound decision making.

Federal/Provincial Partnership

In Figure 3, one possible allocation of responsibilities is presented. This model suggests that the federal government should lead a program of consensus building with respect to social/environmental objectives. In addition the model burdens the federal government with developing broad national legislation and policy outlining the rights of Canadians to environmental quality, with monitoring and reporting on the state of the environment nationally, and with the preparation of more detailed guidelines setting out national environmental quality objectives and indicators of achievement. In all of these responsibilities, the federal government has final decision authority and provinces participate as stakeholders.

In this model, the provincial governments provide the operational arm of environmental stewardship. Provinces monitor and report on the state of the environment provincially and set priorities for taking action in the best interest of communities. Provinces manage the problem-solving stage, administer the process for decision analysis, have decision authority and administer relevent legislation. The federal government would provide an avenue for appeal of disputes between provinces, and disputes over the interpretation of national legislation, policy and guidelines. Any "public" would have the right to appeal through the federal government.

A number of participants at the workshop saw this division of responsibilities as turning over the federal role to the provinces, risking a loss of equity and the emergence of pollution havens.

As an alternative, it was proposed that both federal and provincial governments could retain operational responsibilities. Integrated management could be achieved using CCREM as a forum to negotiate agreements. A Water Commission composed of representatives of both levels of government, industry and selected public interest groups would provide advice to CCREM. However, by its very nature, integrated management provides no final authority, and decision-making can grind to a halt.

While participants were unanimous in supporting the need for national equity, with respect to environmental quality, they did not feel that the group had the expertise needed to reach a conclusion about the division of federal/provincial responsibilities.

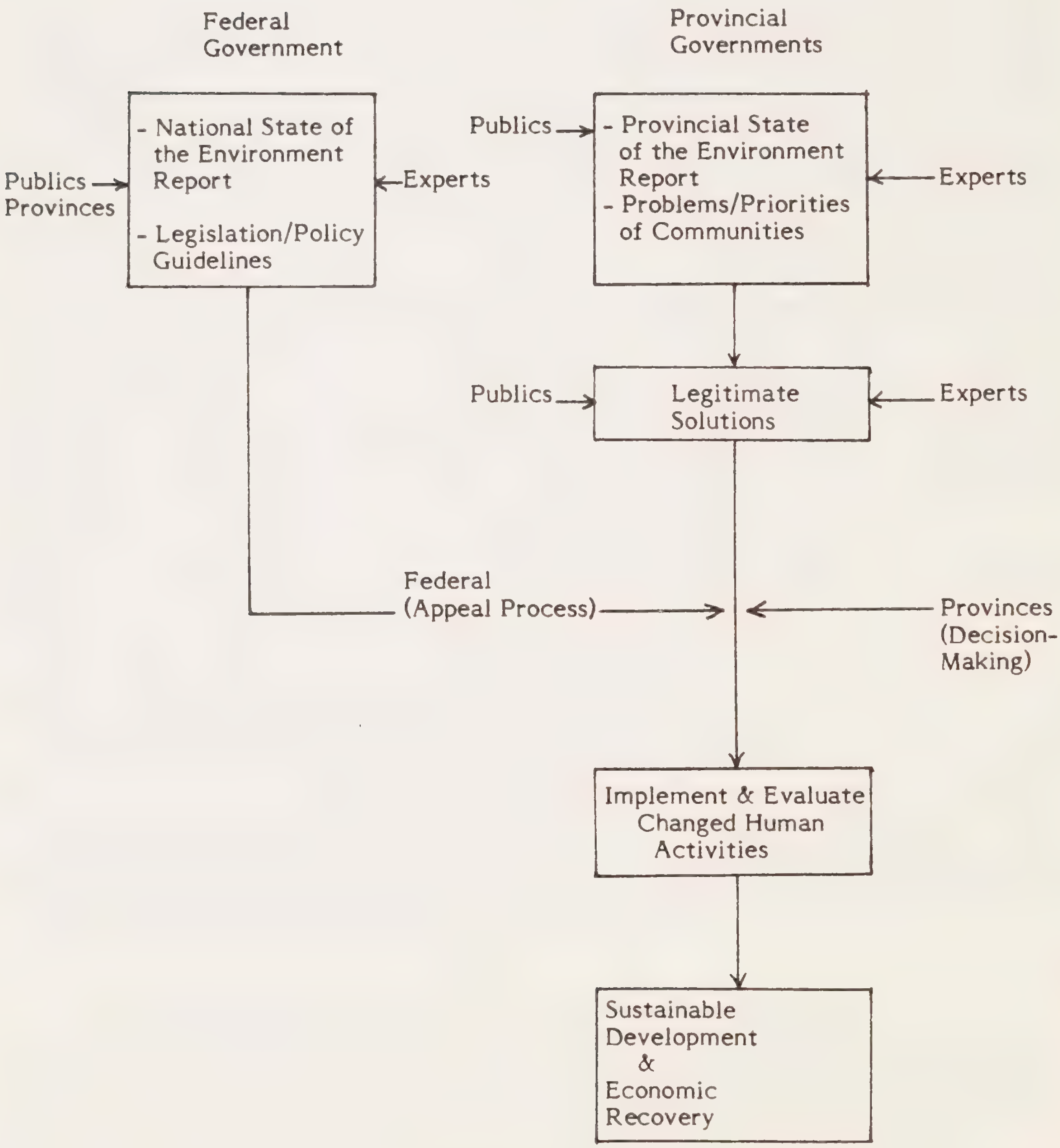
Conclusions

Structure of Decision Processes

- In environmental decision-making uncertainty is the rule not the exception;

- The ingenuity needed to improve the quality of life arises from three reasoning processes: scientific assessment, public/market choice, and the political inference which places the interests of society above the interests of particular publics. Decision-making should draw upon all of these reasoning processes.

Figure 3: Federal/Provincial Partnership for Risk Management



- Three imperatives for responsible social action are recognized: a consensus on social values; cooperative analysis and prediction of the consequences of intervention; and effective procedures for adjusting human activities. Decision processes should include the institutional arrangements and access to expertise needed to satisfy these imperatives.

- Decision-making should include consideration of: the identity and weight of stakeholders; social, economic and environmental objectives; intervention options; predicted positive and negative consequences of options; public perceptions and the legitimacy of consequences, and the sensitivity of the final decision to uncertainty.

- A clearly identified authority should be responsible and accountable for ensuring that decisions are made, implemented and evaluated. Procedures for appeal should be spelled out.

Risk Management Policies

- Policies to guide interventions in human activities should recognize the equal right of all Canadians to environmental quality, and recognize the need to maintain essential ecological processes and life support systems.

- When uncertainty is high, public policies for risk management should (1) define the "due process" for decision-making as well as (2) provide guidance for resolving specific cases.

- Both the guiding policies and individual risk management decisions should consider the consensus developed through consultation with stakeholders and expert advisors.

- Individual decisions should serve the interests of communities and take both positive and negative consequences into account. However, such decisions should be consistent with national environmental legislation, policies and guidelines.

Federal/Provincial Roles in Risk Management

- Two scenarios for the allocation of federal and provincial responsibilities were discussed without choosing between them.

  (1) The provincial governments could become the operational arm of environmental stewardship and administer procedures for risk management. The federal government could function as arbiter of disputes and ensure national standards and equity. To achieve this separation of currently overlapping responsibilities, the federal government would have to delegate some of its authority to the Provinces.

  (2) Both federal and provincial governments could have operational roles in risk management. A Water Commission with members from both governments and appropriate publics would negotiate the distribution of responsibilities. However, unless all governments delegated their decision authority to the Commission there would be <u>no</u> accountable authority.

Improving the Legitimacy of Risk Management Decisions

- Institutional arrangements are needed to negotiate a consensus on priorities for social action. Improved measures of the health of ecosystems are needed. Perhaps most important is the need for improved communication between governments, stakeholders, experts and the public at large.

- Legitimate environmental stewardship will require a deep-rooted social commitment to sustainable development. This social commitment should be supported by improved methods or risk perception and the resolution of conflicting perceptions; educational programs to display the interactions between human activities and natural phenomena; and school curricula to develop better understanding of risk, uncertainty and probability.

- Trust and respect for public policies will require the greatest possible openness and the full display of the elements of decision-making.

Inquiry on Federal Water Policy
Risk Management Workshop

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Inquiry on Federal Water Policy
Risk Management Workshop

Annexes

1. "Issues and Questions for Discussion. Risk Management Workship, Inquiry on Federal Water Policy". Marcia A. Valiante, Director of Research, Canadian Environmental Law Research Foundation. 1985.

2. "Illustrative Exercise in Multi-Attribute Utility Theory Applied to Federal Water Policy. Mark S. Thompson, Harvard School of Public Health, 1985.

3. "Background Notes on Risk Perception". Anne Whyte. Man and the Biosphere Programme, UNESCO, Paris. 1985.

4. "Gaining Perspective on Environmental Issues: A Fresh Look at Familiar Problems". A personal account by Gail Stewart. From: Focus on Great Lakes Water Quality. Volume 10 Issue 1. International Joint Commission, United States and Canada, Great Lakes Regional Office, 1985.

5. "Discussion Topics: Retreat On/From Water Quality". Harold H. Harvey. Zoology Department, University of Toronto. 1985.

6. "Risk Assessment and Standard-Setting for Control of Chemical Hazards in Canadian Drinking Water". R. Stephen McColl, PhD, Department of Health Studies, University of Waterloo, 1985.

ANNEX 1

ISSUES AND QUESTIONS FOR DISCUSSION

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nadian Environmental Law Research Foundation

Fondation canadienne de recherche du droit de l'environnement

18 February 1985

Dr. Carolyn Miller
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Dear Dr. Miller:

As requested, I am sending a short paper of issues and questions for discussion at the Water Inquiry workshop on risk management. I hope the questions are helpful in showing you some of our concerns with this issue.

I look forward to meeting you and participating in the workshop.

Very truly yours,

Marcia Valiante

Marcia A. Valiante
Director of Research

Any consideration of the effects of water management options involves a consideration of the problem of risk and its management. Risk management is a term which has come to mean the quantification of risks associated with exposure to toxic chemicals ("risk assessment") and the determination of an "acceptable" level of risk from such exposure ("risk management").

Risk assessment is sometimes called the "scientific" part of the process and risk management the "political" part. It is important in any discussion of these issues to consider the degree to which these can be separated and their interrelationships

The array of risks to which we are exposed raises the need to regulate in the face of a great deal of scientific uncertainty. This need, and some of the techniques of quantitative risk assessment being applied in the U.S. to address this need, raise a number of issues set out below which could be addressed by the workshop when discussing changing institutions to deal with these questions.

Obviously, in any regulatory decision such as standard setting for exposure to toxic chemicals, the most complete information available should be used. One of the most important problems with using quantitative risk assessment is the lack of data and the limitations of the methods used to gather data.

Given the limitations of these methods (such as reliance on single chemicals, emphasis on cancer, etc.) what kind of information should be required (for example, should there be both positive animal studies and epidemiological studies when regulating cancer risks) and to what degree should information be made public and tested through a peer review process?

In considering changes to the regulatory process, the question of who should participate becomes important, particularly when issues such as how conservative to be in estimating and controlling risks and what is an "acceptable" level of risk. Given the secrecy of existing processes such as that for setting national air quality objectives (where the objectives are set by government representatives whose recommendations and information leading thereto are not disclosed to the public), to what extent should the public (who must bear the risks of regulatory decisions, often disproportionately to the benefits accruing) have a right to participate in such decisions? How credible are regulatory decisions which exclude the public?

Given the large degree of uncertainty surrounding risk assessments, what is the appropriate role for risk assessment? Rather than enshrining a given level of risk as the basis for decision-making, is it more appropriate to use the methods as a way of setting priorities among a group of pollutants for further

assessment and regulation?

A further question is should regulators be trading lives and health off against the costs of pollution control or moving to eliminate risks to the extent possible?

Because of the interrelationships among all parts of the environment, is a multi-media (air, water, land) perspective on risk and control of risk necessary in order to manage risks to water quality from persistent toxic chemicals? How can regulation on this basis be accomplished?

The foregoing are some issues and questions of importance on risk assessment and risk management respecting water management. I look forward to discussing these and other issues at the Workshop.

ANNEX 2

ILLUSTRATIVE EXERCISE IN MULTI-ATTRIBUTE UTILITY THEORY APPLIED TO FEDERAL WATER POLICY

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Illustrative Exercise in
Multi-Attribute Utility Theory
Applied to
Federal Water Policy

North Gower, Ontario
February, 1985

Purpose of Exercise

All numbers in this example have been subjectively estimated by a non-expert in water policy and are arbitrary and debatable. They are intended to show how a possible application of the MAUT technique might proceed.

Policy Alternatives

1. Tough, specific, effluent standards for large industrial polluters.

2. Sale of pollution rights (by periodic auction) set to effect the same water quality level as in 1.

3. Effluent charges on all polluters leading to lower water quality than in 1. and 2.

4. Minimal regulation of pollution, encouragement of such adaptive measures as swimming pools and imported drinking water, and education of the public on precautions to reduce health hazards.

Constituencies and Their Weights

1. Major polluting industries (0.2)
2. Farms (0.1)
3. High environmental concern (0.2)
4. Others (0.5)

Attributes

1. Annual direct cost or gain to Government (100 = gain of $3 billion, 0 = cost of $3 billion).

2. Long-term effects on GNP (100 = 5 percent increase over continuation of status quo, 0 = 10 percent decrease).

3. Effects on industrial profits (100 = 10 percent increase, 0 = 10 percent decrease).

4. Effects on agricultural profits (100 = 10 percent increase, 0 = 20 percent decrease).

5. Level of governmental intrusiveness (100 = industrialists

and farmers not having to spend any time interacting with Government officials, 0 = farmers and industrialists having to spend 10 percent of their time interacting with and awaiting approvals from Government).

6. Water quality for outdoorspeople (100 = Canada in 1492; 40 = 20 percent of surface water being drinkable, 30 percent being swimmable but not drinkable, and 50 percent being unswimmable in regions with over 100 persons per square kilometer; 0 = no water of swimming quality in these regions, considerable travel required for camping and fishing in undespoiled areas).

7. Carcinogesis and teratogenesis (100 = 10 percent decrease in incidence from status quo, 0 = 20 percent increase).

8. Other water-borne morbidity (100 = 10 percent decrease, 0 = 20 percent increase).

9. Near-term disturbance of ecological systems (100 = no disturbance, 0 = reversible eutrophication of 80 percent of the surface water in regions with over 100 persons per square kilometer).

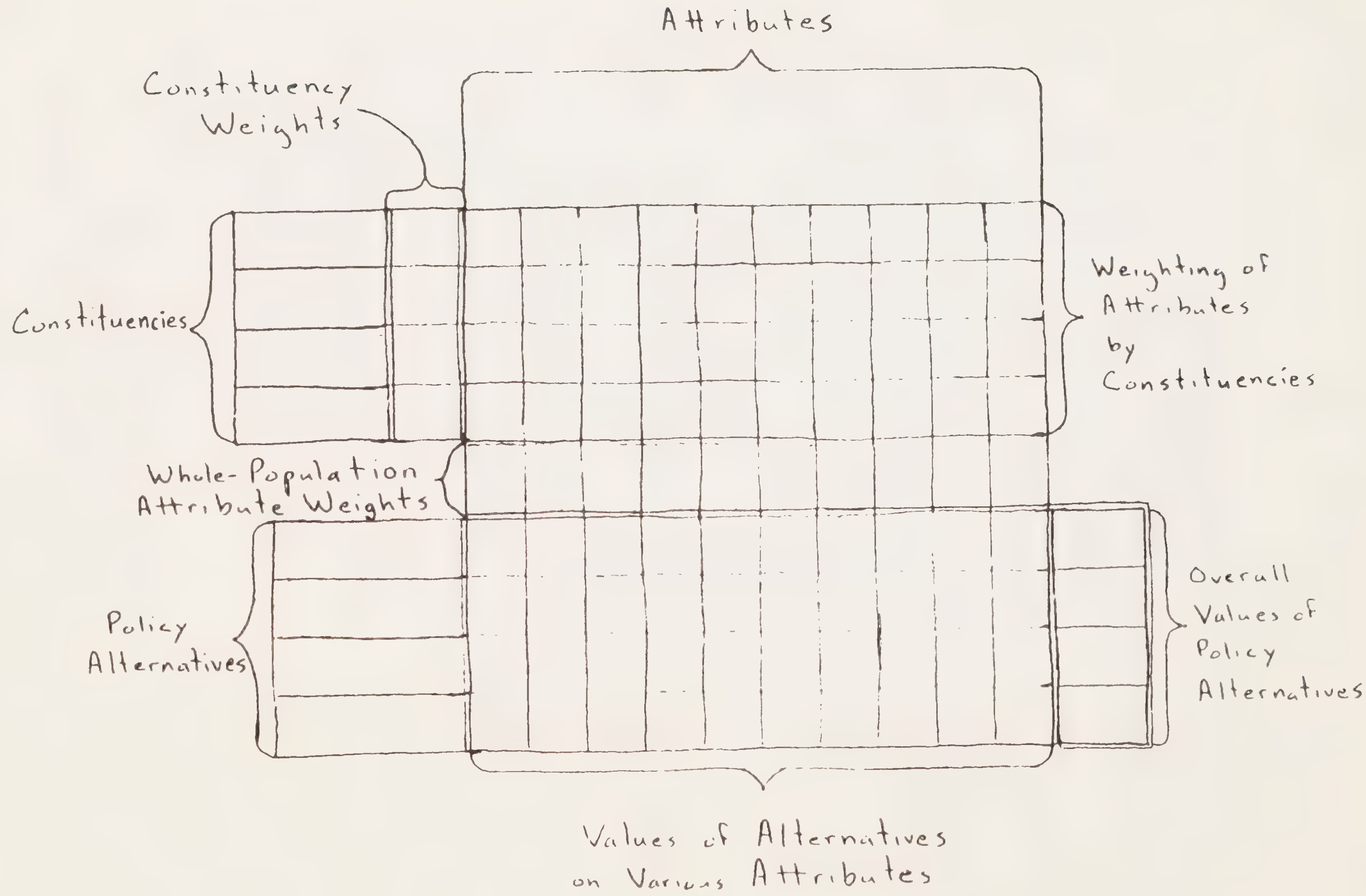
10. Threats to the long-term stability and existence of ecological systems (100 = no threat, 0 = substantial irreversible changes or destruction of ecological systems in 80 percent of the land and water area in regions with over 100 persons per square kilometer).

Illustrative calculation of first whole-population attribute weight:

$$(.2)(.10) + (.1)(.06) + (.2)(.04) + (.5)(.24) = .154 .$$

Illustrative calculation of first overall value of a policy alternative:

$$(.154)(30) + (.170)(0) + (.095)(0) + (.053)(40) + (.078)(0) + (.206)(75) + (.098)(100) + (.054)(100) + (.044)(70) + (.048)(80) = 44.31 .$$


Attributes
Constituency Weights
Constituencies
Weighting of Attributes by Constituencies
Whole-Population Attribute Weights
Policy Alternatives
Overall Values of Policy Alternatives
Values of Alternatives on Various Attributes

		Attributes										
	Constituency Weights	Gov Cost	GNP	Ind. Profits	F Profits	H Intrusion	Outdoors	Cancer & Defects	Other Morbidity	Near-Term Ecology	Long-Term Ecology	Overall Values of Policy Alternatives
Constituencies												
Industry	.2	10	20	40	—	14	08	.02	02	.02	02	
Farmers	.1	.06	.08	—	.48	.10	.16	.02	.02	.04	.04	
Outdoors	.2	.04	.06	—	—	.10	52	.06	.04	.08	.10	
Others	.5	.24	.22	.03	.01	.04	.14	.16	.08	.04	04	
Whole-Population Attribute Weights		.154	170	.095	.053	.078	.206	.098	054	.044	048	
Policy Alternatives												
Standards		30	0	0	40	0	75	100	100	70	80	44
Rights		100	40	30	0	70	75	100	100	70	80	68
Charges		70	45	40	20	60	40	80	80	40	40	52
Adaptation		10	100	100	100	90	10	0	0	0	0	42

Weighting of Attributes by Constituencies

Values of Alternatives on Various Attributes

ANNEX 3

BACKGROUND NOTES ON RISK PERCEPTION

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BACKGROUND NOTES ON RISK PERCEPTION

Anne Whyte
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O U T L I N E

1. Definitions

2. Risk perception compared to risk analysis

3. Psychological aspects

4. Sociological aspects

5. Characteristics of the hazard

6. Data limitations

7. Two major policy questions

1. DEFINITIONS

1.1 Risk perception

Risk perception is the process whereby risks are subjectively, or intuitively, estimated, understood, and evaluated. Although the term is often associated with lay people's assessment of risk, scientists and policy makers also estimate risks intuitively, especially when they are outside their own areas of expertise.

1.2 Public perception of risk

The public perception of risk is a concept, more useful to public policy than to science, which seeks to capture dominant views in society about particular risks. Since the main tool for estimating public perception is the social survey, the measure is almost always perception of a specified risk or class of risks (eg dam burst, dioxines in drinking water).

Risks have to become public policy issues before public perception of them is surveyed. By that time, information about the risk and/or related events, have reached the public through mass media. Inevitably, therefore, public risk perception, as measured, tends to reflect the way the issue has been addressed in the mass media, and is highly sensitive to hazard and media 'events'.

2. RISK PERCEPTION COMPARED TO RISK ANALYSIS

The simple physical model of risk used as the starting point in much risk analysis (Risk= probability x consequence) is inadequate for risk perception. The reasons include the following:

(a) there are limits and biases inherent in human information processing, which particularly affect the subjective estimation of probabilities;

(b) the usual measures of consequence (deaths, dollars lost, person-days of work lost) assume that people perceive all ways of death as equal, and all lives equal in value, which they are not; (cf. long painful death vs. quick heart attack; death vs. great physical incapacity; death of breadwinner vs. child or grandparent);

(c) it does not account for the fact that similar consequences which have different causes are perceived differently in terms of their public acceptability (cf. 'natural', Act of God, managerial incompetence, inequitable policy);

(d) it does not provide for the changing relationship between the probability and consequence expressions; as the conceivable consequences increase, the salience of probabilities deceases until in the case of the worse case scenario for catastrophic events, it reaches vanishing point; what is possible becomes more important than whether it is probable.

It is more useful to view these elements in risk perception, not as the idiosyncracies of the ignorant, but as challenges to the scientific and policy communities to improve their own measures of risk.

3. PSYCHOLOGICAL ASPECTS

3.1 Perception of probability

More attention has been given to the perception of probability than to the perception of consequences in risk perception research, particularly by psychologists, probably because perceived probabilities are more easily quantified and compared with mortality and morbidity statistics.

Experimental findings indicate that:

(a) people tend to underestimate the differences in probability between low and high frequency risks. In other words, the range of perceived probabilities is narrowed compared to statistical data; frequent causes of death

(cancers, heart disease) are underestimated and infrequent but dramatic causes of death (floods) are exaggerated.

(b) people tend to underestimate events that are stochastic in comparison to certain events (prospect theory);

(c) the 'errors' in subjective probabilities are due to certain limitations in human information processing. These include heuristic biases such as representativeness, (gambler's fallacy), availability, and anchoring; certainty and isolation effects;

3.2 Decision framing

For decisions made under uncertainty, the 'frame' of the decision (what is included, what is excluded) powerfully affects the choices arrived at. For example, non-users of seat belts were forced to frame their decision in terms of risk death per individual trip (1 in 3.5 million for USA) whereas users framed their decision in terms of the risk over their whole lifetime (1 in 1000). One of the most powerful roles of the mass media, and of risk education, is to influence the decision-frames of the public.

3.3 Perception of uncertainty

Several psychological responses are known to cope with the problem of uncertainty. These include:

(a) to perceive events as falling into a pattern. This gives the individual a sense of control over the environment in that he feels he can predict or expect when the next event will occur. It is a common phenomenon in the perception of floods.

(b) if people feel control, the level of risk that they find acceptable is generally higher (voluntary-involuntary dimension).

3.4 Perception of hazard cause

An important aspect of the psychology of risk perception for policy is the effect of attribution of causality. The scientific distinction between 'natural' and 'man-made' does not necessarily concide with perceived causes. Hazards such as floods are increasingly viewed by the North American public as man-made rather than Acts of God.

Experimental studies have shown that initial perceptions about cause and effect are remarkably resistant in the face of later, conflicting information.

3.5 Perception of benefit

It is axiomatic that people will accept higher risk if they are compensated with higher benefit. The question is one of decision-framing; what costs and benefits (and to whom) are included in the equation? Social surveys indicate that the public can make trade offs between, for example, economic growth and environmental protection. However, where health risks, such as drinking water quality, are concerned, the public view is usually to reduce risks even at the costs of also reducing benefits.

4. SOCIOLOGICAL ASPECTS

There is evidence of broad socio-economic and demographic differences in risk perception. These patterns are more consistent for the knowledge component of public perception (men, younger people, better educated usually have more information) than they are for the emotive, anxiety component (although generally, women and especially mothers with young children) express most concern about risks.

Regional differences across Canada are found for perception of certain risks reflecting differences in public policy agendas.

4.1 Role of information and mass media

A distinction needs to be drawn between direct and indirect information; wherever a hazard remains below human sensory perception, the role of information, especially mass media reports becomes magnified. Credibility in the source of the information affects how it is received, and this is particularly a problem for government. Although the public may recognise that journalistic accounts of events may be biased, they often feel that "there is something in them".

4.2 Expectations of government

The perceived problem agenda varies with the level at which the public feel responsibility for action lies. Thus health is seen as an individual problem whereas environmental quality is seen mainly as a community and provincial responsibility.

There is a mismatch between public espectations of the federal government's capability to solve major national problems and public evaluation of the way problems have been handled in the past. However, the Canadian public expects the government to protect them by regulating risk.

4.3 Historical dimension

In 1960, or even in 1970, the term 'risk assessment' was unknown to the general public in Canada, within 10-15 years, the public

has become aware of risks as a group of phenomena. They are more risk-conscious, and they believe that they are exposed to more risks today than in the past, especially chemical risks.

5. CHARACTERISTICS OF THE HAZARD

The characteristics of the risk; its magnitude, frequency, cause and impacts, interact with the psychological and sociological dimensions in risk perception. Thus the risk of flooding and the risk of chemicals in drinking water are both water related, but there the similarity for risk perception ends.

CHARACTERISTICS OF RISKS WHICH AFFECT PERCEPTION AND RESPONSE

Higher Salience	Lower Salience
High probability Recurrence interval within living or historical memory Expected to occur soon	Low probability Impacts not previously experienced/long time in past Longer time in future
Extreme event Imaginable/definable event	Lower variability from norm No clear beginning/end
High consequences Direct impact on people´s welfare Loss of human life Identifiable victims Impacts grouped in space/time	Lower consequences Indirect effects No human lives lost Statistical victims Impacts random
Reasonably certain to occur Effects/mechanisms understood Dramatic impacts	Uncertain/controversial Effects/mechanisms not under-stood Less perceptible impacts

6. DATA LIMITATIONS

Data on risk perception have been obtained primarily through three methods:

a) laboratory experiments such as those conducted by social psychologists on heuristic biases;

b) field studies, such as those carried out by geographers on perception of natural hazards in tornado zones, floodplains etc;

c) social surveys, such as those conducted by sociologists and public pollsters on national samplers of the population.

Each of these methods brings with it various strengths and weaknesses, of which policy makers should be aware.

7. TWO MAJOR POLICY QUESTIONS

7.1 If public risk perception is to be included in risk assessment as public policy in a more formal way than it is at present, major questions are:

(a) how to measure public perceptions?

(b) how to reconcile conflicting perceptions?

(c) how to weigh public perceptions versus scientific, 'expert' opinion and other inputs to public policy;

7.2 Should risk assessment include the costs of perceived risk (ie. enxiety before the event; alienation from government and society)?

Some of these costs of perceived risk are theoretically measurable in dollar costs, such as reduced productivity through anxiety and increased government spending for public participation in policy making.

Even where dollar values cannot be assigned, there are social costs to risk perception which can be enumerated separately from economic accounting.

ANNEX 4

GAINING PERSPECTIVE ON ENVIRONMENTAL ISSUES

A FRESH LOOK AT FAMILIAR PROBLEMS

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FOCUS On Great Lakes Water Quality

Gaining Perspective on Environmental Issues: A Fresh Look at Familiar Problems

A Personal Account by Gail Stewart

The Environmental Challenge

I think the environmental challenge is recognized by all of us but it has been hard to know how to respond effectively. The incidence of environmental problems is widespread and some are of long standing, the risks are unknown but potentially very high, and action on specific issues is often in conflict with economic practice if not economic imperatives.

The situation I found, as I became interested in environmental issues and was invited into projects where people were addressing them, was almost invariably one of some agitation. Someone, usually a natural scientist, or occasionally a native person, was obviously concerned, and alleging that something was deeply wrong with the way we were thinking about environment. Others, including often other natural scientists or social scientists, were trying to respond but the responses were obviously not satisfactory and no dialogue resulted which was meaningful to both parties. It was clear that we had here a case of differing perceptions; that were apparently difficult to communicate, but I was unable to pinpoint the source of the difficulty or provide a bridging perception.

As I listened to people discussing the problems that they saw (and the work I was doing in the community and for Environment Canada provided an extraordinary occasion for talking with many people on the question of the relation between environment and economics) I was struck by the different meanings which people gave to the term environment. to some it was an all-encompassing reality, to others it was the great outdoors, and still others would distinguish natural systems from man-made environments. Others saw it in human value terms, as resources or amenities or unwanted goods such as pollution. And all of us referred to it differently on different occasions. Further, it was the subject of advocacy, intervention, regulation, moralizing, threat, management, charity and nurture in a bewildering array of policies.

Eventually I was able to make a distinction helpful to me (a distinction originally developed for use in other fields), and began to use it. Working as a member of the community with Environment Canada, I was able to demonstrate how the Department, by its manner of thinking at the corporate level if not in every program, had been taking one approach to the environment when it might have been taking another that would have been much more powerful and allowed it to pursue its mandate more effectively. In other projects too, I found that I could see more clearly how progress might be made. It become apparent that much of what we were doing with respect to environmental action was dealing with symptoms, and dealing in increasingly risky ways. It appeared to me faster, more effective, and more pleasant progress on environmental issues might be made if we were to address quite directly the core of the underlying problem, which was a

idespread intellectual error in the onceptualization of the environment-ociety relationship. The analogy that mmediately came to mind was the ield of health care, where fostering ersonal health and fitness may be aster, safer and more effective in the ong run than continuing to fight ickness without attending in a prior vay to health.

The Finding

The finding itself concerns a distinction n the point of departure that we use n the logical construction of our approach to environment, and it may be stated succinctly. For purposes of government, economics and public affairs generally, and in our daily lives, we have been approaching environment as an element in the context of human affairs. However, each of us if asked would probably say that in truth human affairs are an element in the context of the environment, and in this we would have the support of the natural sciences. From this perspective we must then be seen as making a fundamental error when we fail to take a priori account of the environmental context of our personal and social context.

The constructional logic itself is profoundly simple. Suppose, for the purposes of example, we take economic activity as the sort of human affairs with which we are concerned. Let economic activity be x, and the environment by y. Now consider whether, for practical purposes, y should in the first instance be considered a component of x or x be considered initially as component of y

Most of us, it appears, hold in our minds and use both models. In one approach environment takes its place, along with other current issues, as presenting a set of problems we must address and act upon. In the other approach, familiar to geography students and in television documentaries on the earth and its history and available to us when we look at the heavens and then back at ourselves, we take our place, whatever else may characterize us, as elements within an encompassing environment. Both personal and public policy-making would be improved by the cross-substitution of x for y. This suggests that consciousness-raising and the practising of new perceptions would be a much preferable thrust for environmental policy than the extension of regulation in a context where the error remains in place. The former course leads towards the nurture of the environment, the latter towards the highly risky activity of global environmental management.

Each perspective is familiar as a starting point for thinking about environment. A sequence of decision-making that begins, however, by seeing environment as component of the economy, and for convenience deals with environment under the separate categories of resource issues, amenity and conservation issues, and pollution issues, (which is the typical way that environment is currently dealt with in economic and government and household decision-making processes in our society), actually creates risk: the risk that we will pursue management rather than nurture — that we will fail to see the forests for the forestry. (I have argued in another context, for example, that the creation of the new federal department of forestry is probably a good idea, provided that everybody understands that this does not relieve Environment Canada of its supervening responsibility for forests.)

Clearly, an approach which places environment as content rather than context for the economy is inferior in terms of both science and popular understanding to one which begins by acknowledging the ubiquitous and encompassing character of environment. An approach which addresses first the condition of our common estate and ourselves as part of it before turning to specific economic issues involving aspects of the environment seems clearly preferable. To proceed otherwise would now not only be identifiably irrational but would sustain and deepen present risk and invite ever-greater risk-taking.

The argument has immediate implications for the sequence of agenda items at meetings, for the directions of research, for the further development of public policy an corporate and government planning, for household operation, for environmental education, and for almost every other aspect of our affairs. It appears that we have known about our situation as active participants in the biosphere for many years but have not imported this knowledge into the logic of our public and private decision-making processes in consequence of the point of departure we have used for our contextual logic. With the appropriate first step in the contextual logic missing from our mental and symbolic models of the world; our environment has tended to remain invisible in our day-to-day decision-making and we keep forgetting where we are, at home in the thin skin of a spinning planet.

The communications problem between our agitated natural scientist (or native person) and the rest of us has persisted because, while we have both been talking about x and y and using the same works, we have not stated from the same implicit contextual relationship between x and y. It is a familiar problem in

inter-cultural communications, now applied to environment. A cross-substitution of contexts (for example, economics and environment) is the intellectual work that now calls us, with its associated process of language generation. (The activity would probably benefit from being given an appropriate name.)

Further, it seems clear that for our own safety if nothing else we must develop a global metaculture that, for initial puposes at least, sees x in the context of y. We need to practice talking about and seeing ourselves in environmental perspective. That will serve both the environment and possibly even a product of it.

The rare individuals in our society who against all odds have retained or developed that perspective may be able to help. For the most part, however, we are probably on our own in discerning its practical implications for our lives and customs. I personally think that informal consciousness-raising groups would be a good idea. The perspective, even when fleetingly grasped, is quite extraordinarily enlivening and plump with common sense or intuitive knowing. It immediately opens such "insurmountable opportunities" as could set off a new age at least as exciting as was the age of exploration when the world was discovered to be round rather than flat.

The challenge is intellectual and the enemy some of our present habits of thought. It is the kind of problem where remarkable progress can be made once it commands attention. I would leave you with the thought that it is an error in our contextual logic — an error in our manner of thinking about environment which is in turn having reflexive consequences — that is at the core of our environmental problems. By the same token, I believe that it is not so much moral exhortation and advocacy and regulation as it is intellectual work and new language development and information gathering from a new perspective that are now the priorities with respect to environment. What is needed is a new way of seeing our situation, based on a cross-substitution in our contextual reasoning.

Excerpts from notes for a talk delivered at a meeting in Ottawa September 25, 1984.

ANNEX 5

DISCUSSION TOPICS: RETREAT ON/FROM WATER QUALITY

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STATHMERE HOUSE, February 20-22, 1985

DISCUSSION TOPICS: "RETREAT ON/FROM WATER QUALITY"

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1. Loss of Diversity in Animal Life from Aquatic Environments

Surveys of streams, rivers, lakes, conducted at intervals show a trend in loss of species over time. For example, the eight streams tributary to the Niagara River (Canadian side, above the escarpment), such as Usher's Cr., typically contained about 25 species of fishes during the 1950's. The most recent surveys show only 5-6 species remaining. Similarly sampling sites in Burlington Bay show the number of fish species declining from 20-30 four decades ago to 4-5 currently.

Such loss of species has no single cause. The effects of many environmental perturbations are cumulative. The strategies currently in place for protecting the environment do not prevent this from happening.

2. Dumping of Unspecified Contaminants

The permit issued to the Hooker Chemical Co. 1975-80 allows for the dumping of up to 950 lbs/day of halogenated organics into Lake Ontario. The materials to be dumped are unspecified as to composition, toxicity, life expectancy, synegistic action, breakdown products, etc. The current permit is for 284 lbs/day.

Our current strategy for protecting the environment is based on the sequence: identification, toxicity, testing, establishing criteria, drafting regulations, monitoring emissions, seeking compliance, and court action. This strategy fails completely when the problem is unknown.

Do we need an alternative strategy? For example, dumping will be permitted only when the material to be dumped can be demonstrated to be harmless to the environment.

3. Substances too Toxic for Discharge in any Amount

The dioxin T.C.D.D. (2, 3, 7, 8 tetra chloro dibenzo dioxin) is one of the most toxic substances known to man. It bioaccumulates and renders fish unsafe for consumption in concentrations of p.p.t. It has been calculated that about 5 g discharged annually into Lake Michigan would suffice to put the fish from this lake out of compliance and thus destroy the fishery. This 5 g/year can be achieved from sources discharging below the level of detection.

The current strategy for protection requires monitoring at (reliably) detectable concentrations. Is the alternate strategy: (a) to ban the use of this chemical in the Great Lakes basin? (b) to ban its manufacture within the basin?

Should there be a list of chemical agents to be treated as per (a) and (b)?

4. The Precariousness of Domestic Water Supplies

The water quality objective for T.C.D.D. (2, 3, 7, 8 tetra chloro dibenzo dioxin) is put at 0.25 p.p. quadrillion in drinking water (U.S.E.P.A.) Lake

Ontario has a mass of 3.11×10^{15} kg. Thus about 1.5 lbs of T.C.D.D. are required to achieve a concentration of 0.25 p.p.q. The Hyde Park dumpsite, Niagara River drainage, contains a ton of dioxin.

The drinking water objective for lindane (hexa chloro cyclo hexane) is 20 p.p. trillion. A concentration of 1 p.p.t. would thus require 3 mt ton to be added to Lake Ontario. The Love Canal dumpsite contains 6,900 tons of hexa chloro cyclo hexanes.

These and other dumpsites along the Niagara River are leaking into the underlying limestone and thence into the river and Lake Ontario, at an unknown rate. Leakage of 0.1% to 1.0% of dumpsite contents into Lake Ontario would put it out of compliance.

There is no strategy in place to prevent this contamination of Lake Ontario.

What is the alternative strategy? Does Toronto, for example, build an aquaduct from Georgian Bay to Toronto to guarantee a supply of safe drinking water?

5. The Solution to Pollutions may not be Dilution

It has come to be accepted as a truism that, all substances are toxic to life at some high concentration, and the corollary is that all substances are harmless at some low concentration. This assumption needs to be challenged. For example, phosphorus has two radioisotopes (^{32}P and ^{33}P). Phosphorus is taken up quickly by cells and frequently is contained in the cell nucleus where the opportunity for damage through emissions is maximized. More importantly, phosphorus is taken up into DNA and RNA. The radionuclides of P break

down into sulfur, making nonsense of the genetic code. Thus, it is harmful in all concentrations.

There is a second family of substances for which discharge could be banned at any concentration. For example, Lake St. Mary was contaminated with mercury through large-scale losses of Hg from chlor-alkali plants, prior to 1971. The lake is still out of compliance, and larger fishes exceed the 0.5 p.p.m. Hg standard. Nonetheless Hg discharge of 1 lb per day is still permitted into the lake.

Alternate strategy: Can we ban the discharge of contaminants where the environment is already out of compliance?

6. The Catch-22

The case against acid rain is based on the loss of resource, but if the resource is lost, then protection becomes unnecessary. At the Sandefjord Conference, a spokesperson for CEGB commented to the Norwegian hosts that as 55% of the lakes in Southern Norway had lost their fishes, it was not worth the cost of reducing emissions to save the rest. Canadians may find themselves in a similar situation, in that the early evidence of acidification of the environment has not led to action to reduce emissions. Indeed, there are still no defined criteria for assessment of acidification. The criticisms of the current research approach, as included in the Canada-U.S. Memorandum of Intent, have not led to any operational directives to researchers.

Alternative strategies: (1) Continue to search for a U.S.-Canada accord. (2) Proceed independently to reduce emissions.

ANNEX 6

RISK ASSESSMENT AND STANDARD-SETTING FOR CONTROL OF CHEMICAL HAZARDS IN CANADIAN DRINKING WATER

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Risk Assessment and Standard-Setting for Control of Chemical Hazards in Canadian Drinking Water

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A paper prepared for the Risk Management Workshop,
Inquiry on Federal Water Policy, Environment Canada
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I. Fundamental Considerations:

Contamination of drinking water by toxic chemicals currently represents a pervasive environmental concern for many Canadians. Apprehension about the quality and safety of drinking water arises both from the scientific uncertainties in setting standards for water toxicants, and the public's perception of the health risks associated with these standards.

From the scientific viewpoint, the main considerations that are included for deriving drinking water safety standards are as follows:

1. Exposure:

   Water is an essential component in the human environment. Since consumption is obligatory for the maintenance of life, exposure to water toxicants occurs continually throughout the entire lifespan of all individuals in the population. Exposure can also occur through contamination of water-based prepared foods and beverages and from biomagnification of water toxicants through the food chain.

2. Susceptibility:

   Since exposure to water toxicants is unavoidable, hyper-susceptible members of the population (such as infants, the elderly, and those with special health problems) will be especially at risk for toxic effects from water contaminants. Individuals with unusually large amounts of water intake (e.g., workers in hot or strenuous occupations) may also be at increased risk.

3. Control Procedures:

   As a homogeneous substance that is generally supplied from a single source (at least in urban areas), water toxicants are relatively easy to detect, monitor, and control compared to other modes of exposure such as air pollutants or food contaminants. Since water toxicants are especially amenable to control procedures, allowable levels of these toxicants should follow the ALARA principle (As Low As Reasonably Achieveable) to minimize health risk in the population.

4. Nature of Toxic Effects:

   Three basic classes of water toxicants are each assessed and regulated in different ways. For inorganic toxicants (mainly metals), standards are frequently derived from occupational exposure standards or epidemiological studies on human populations. For organic toxicants, which are less well characterized in their chemical and toxicological properties, animal chronic toxicity studies are more frequently utilized to produce standards. For carcinogenic substances (usually organic) more specialized animal bioassay and extrapolation procedures are used to estimate carcinogenic risks.

5. Quality of data:

Where sufficient amounts of valid reliable toxicological data are available (especially direct human toxicity data), the size of safety factors used for setting acceptable exposure standards are relatively small. Conversely where data is incomplete, unreliable, or not directly related to human exposures (i.e., in experimental animals), larger safety factors must be incorporated to take into account the greater uncertainty in the formulated standard.

. Regulation of Drinking Water:

Drinking water standards in Canada are delineated in Guidelines for Canadian Drinking Water Quality (1978). Since drinking water quality is a provincial responsibility, the federal standards are not legally enforceable, but serve as guidelines for provincial standard-setting. In almost all cases, the provincial regulations are identical to the federal guidelines, although some provinces have additional special standards for locally significant water contaminants.

The primary water standard in Canada is termed the MAC (Maximum Acceptable Concentration), defined as the maximum allowable concentration of contaminants not producing visible health effects or objectionable aesthetic properties (taste, odour, appearance). Although the MAC standard is defined as a "safe" level of exposure, the Canadian guidelines do acknowledge that much more stringent criteria are generally desirable to ensure the highest possible water quality. Two types of subsidiary standards are therefore specified: the objective concentration (OC) represents as "ultimate quality goal for both health and aesthetic purposes", while the target concentration is used to define acceptable limits for radionuclides which theoretically have no threshold of toxicity. Canadian drinking water standards are exceptional in a number of ways. The number of regulated substances, both inorganic and organic, are significantly more extensive than in many other countries, such as the United States. Likewise, the specification of dual level standards for maximum (MAC) and optimum (OC) toxicant concentrations is not reproduced in the American context. Sampling of water supplies is also more frequent.

In comparing the Canadian and U.S. MAC standards, there is a generally close agreement for most chemicals. This is not surprising considering that both sets of standards are based on similar or identical scientific data and criteria. However, in the case of certain putative organic carcinogens such as the trihalomethanes (THM's), the Canadian MAC standard is much more lenient (350 ppm) than the U.S. standard (100 ppm). These dissimilarities are based mainly on the differing scientific rationale governing the risk estimation for carcinogenic hazards.

In the Canadian rationale, THM's (mainly chloroform) are considered as "epigenetic" cardinogens, acting on a non-genetic process leading to cancer. Conversely, the U.S. criteria treat THM's as potential "genotoxic" carcinogens.

The main difference between these two mechanistic rationales is that there is a theoretical toxicological threshold for epigenetic carcinogens, so that small doses are not dangerous, while for genotoxic carcinogens there is no theoretical threshold. In the latter case, even minute exposure would lead to a small but significant risk of cancer so a more stringent standard must be applied. A similar mechanistic rationale allows for a MAC standard for nitrotriacetic acid (NTA) in Canada, whereas the substance is banned in the U.S.

III. Standard-Setting:

It is remarkable that many water quality standards are not derived from direct measures of water-related toxicity but rather from health effects in occupational settings or in experimental animals. One of the greatest obstacles to assessing risk for water toxicants is the inability to obtain reliable and unambiguous evidence of health effects from trace amounts of toxicants, especially organic toxicants. For example, numerous epidemiological studies (both ecological and case-control) have demonstrated a weak trend toward increased G.I. and G.U. cancers in populations exposed to THM's and other organic contaminants in water. However, the magnitude of the effect is slight (only about 2-fold excess risk), so that statistical unreliability and confounding variables obscure the significance of the data.

In the case of some inorganic toxicants, such as barium, a direct adaptation of the industrial TLV standard can be performed. In other cases, chronic animal studies are utilized to derive an "acceptable daily intake" (ADI) standard, such as for cadmium. Certain common environmental pollutants, such as lead and fluoride, can be assessed directly from clinical or epidemiologic evidence. For most inorganic toxicants the safety factors for drinking water are unusually small, about 2-4 fold below the generally accepted threshold of toxicity. The small margin of safety provided by these standards remains an ongoing source of concern.

For non-carcinogenic organic toxicants (including pesticides and herbicides), most standards are derived from chronic toxicity studies in animals. Generally the standard is derived by taking the NOEL (no observed effect level) value from animals (2 species) and dividing by a safety-factor (usually 100) to provide an adequate margin of safety. If there is only limited animal data, an addition factor of 5 or 10 is introduced to account for the uncertainty of the dose-response relationship. Therefore in many cases, the overall safety factor is 500 or 1000.

Finally, for carcinogenic substances, there is no commonly acceptable procedure for reliably estimating risk at low levels of exposure. Estimates of risk based on current statistical methods produce standards which are extremely stringent, so much so that they cannot be realistically applied using currently available technology.

IV. Recommendations:

1. Many drinking water contaminants have not yet been characterized either chemically or toxicologically. This problem is especially relevant to organic chemicals produced by toxic wastes, chemical discharges, or by chlorination reactions with organic constituents of water. Better detection and screening procedures need to be developed.

2. The primary standards for drinking water (MAC's) should be derived more directly from human epidemiological data or clinical data, rather than as indirect adaptations of occupational or air pollution standards.

3. The values assigned to safety factors in deriving MAC or ADI standards should be continually re-assessed. For inorganic toxicants, more stringent safety standards may be required. For non-carcinogenic organic toxicants, safety factors should be reduced as more reliable animal data becomes available.

4. For all types of toxicants, more attention should be focused on the mechanistic aspects of toxicant action, so that standards may be derived with a more fundamentally valid set of criteria. This is especially necessary in the case of suspect carcinogens, where different rationales may be applied for genotoxic and epigenetic carcinogens. This approach would produce more realistic and biologically relevant standards for drinking water carcinogens.

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Inquiry on Federal Water Policy

Enquête sur la politique fédérale relative aux eaux

Research Papers

Documents de recherche

THE ROLE OF WATER DEMAND MANAGEMENT IN A FEDERAL WATER POLICY

by

James E. Robinson
and
Marv Anderson

Canada

Inquiry on Federal Water Policy
Research Paper #20

THE ROLE OF WATER DEMAND MANAGEMENT IN A FEDERAL WATER POLICY

by

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June, 1985

THE INQUIRY ON FEDERAL WATER POLICY

The Inquiry on Federal Water Policy was appointed by the federal Minister of the Environment in January of 1984 under the authority of the Canada Water Act. The members were Peter H. Pearse, chairman; Françoise Bertrand, member; and James W. MacLaren, member. The Inquiry was required by its terms of reference to review matters of water policy and management within federal jurisdiction and to make recommendations.

This document is one of a series of research papers commissioned by the Inquiry to advance its investigation. The views and conclusions expressed in the research papers are those of the authors. Copies of research papers and information on the series may be obtained by writing to the Enquiry Centre, Environment Canada, Ottawa, Ontario K1A 0H3.

Frank Quinn
Director of Research

Abstract

This paper presents an overview of water demand management, its importance, and how it should be integrated with supply management for water and wastewater systems. Demand management measures in agriculture include dryland cultural practices, improved water delivery systems (both off-farm and on-farm), water scheduling, and water metering; each of these could provide productivity gains of 15 to 25 percent, allowing a doubling of irrigated production with existing supplies.

In the industrial sector, recycling processes can reduce water use per unit of output by up to 97 percent for individual firms, and perhaps up to 75 percent in industries such as pulp and paper. Municipal water use can be reduced by 13 to 50 percent for each of: improving distribution system maintenance, metering, rate structure modification, and use of insulated and heat-traced services in northern communities. Long term reduction of over 25 percent can be achieved in new residential development by ensuring new structures include more water-efficient fixtures and appliances.

Despite institutional problems, the federal government can assist through improved coordination among departments, re-focussing supply-oriented technical assistance, additional research and extension education, support for public information services including interest groups, tax incentives, programs and actions to facilitate use of more water-efficient fixtures, and support of provincial initiatives related to demand management.

Résumé

Ce rapport présente un aperçu de l'importance de la gestion de la demande en eau et de la façon dont celle-ci pourrait être intégrée à la gestion des approvisionnements pour les systèmes de distribution et les systèmes de traitement des eaux usées. Les mesures de gestion de la demande en agriculture comprennent l'utilisation de techniques de type cultures non irriguées, l'amélioration des systèmes de distribution (tant sur les fermes qu'à l'extérieur de celles-ci) le calcul des quantités d'eau requises et le comptage de l'eau. Chacune de ces mesures pourrait apporter des gains de productivité de l'ordre de 15 à 25%, ce qui permettrait de doubler la production des terres irriguées sans augmenter les approvisionnements actuels.

Au niveau du secteur industriel, les méthodes de recyclage peuvent réduire la quantité d'eau utilisée d'un facteur pouvant atteindre 97% pour les petites entreprises et peut-être 75% pour des secteurs tel les pâtes et papiers. L'utilisation d'eau au niveau municipal peut être réduite de 13 à 50% par chacune des méthodes suivantes: amélioration de l'entretien du système de distribution, comptage de l'eau, modification des tarifs et utilisation de réseaux thermiquement isolés dans les communautés nordiques. Une réduction à long terme de 25% peut être atteinte dans les nouveaux projets résidentiels par l'utilisation de fixtures et d'appareils ménagers utilisant moins d'eau que leurs prédecesseurs.

Malgré les problèmes institutionnels, le gouvernement fédéral peut apporter sa contribution par l'amélioration de la coordination interministérielle, par la réorientation de l'aide technique relié aux approvisionnements, par la mise en place de programmes de recherche et d'éducation supplémentaires, par le support à l'information du public y compris les groupes d'intérêt public, par la mise en place de stimulants fiscaux, par l'établissement de programmes et actions afin de faciliter l'utilisation de fixtures plus performantes et par le support d'initiatives provinciales reliées à la gestion de la demande.

Acknowledgements

Many people assisted in the preparation of this paper in addition to those whose works are cited in the text. A partial list includes R. K. Beach, D. Bjonback, J. Bulkley, B. Cooper, W. Drake, T. Hennigar, J. Pawley and A. Zdanowicz, all of whom provided helpful comments on an earlier draft. J. DeBoers and M. Fortin also provided access to helpful information.

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Thanks must also be given to the Inquiry and its staff for making this work possible.

Apologies are offered to any others overlooked.

J. E. R.

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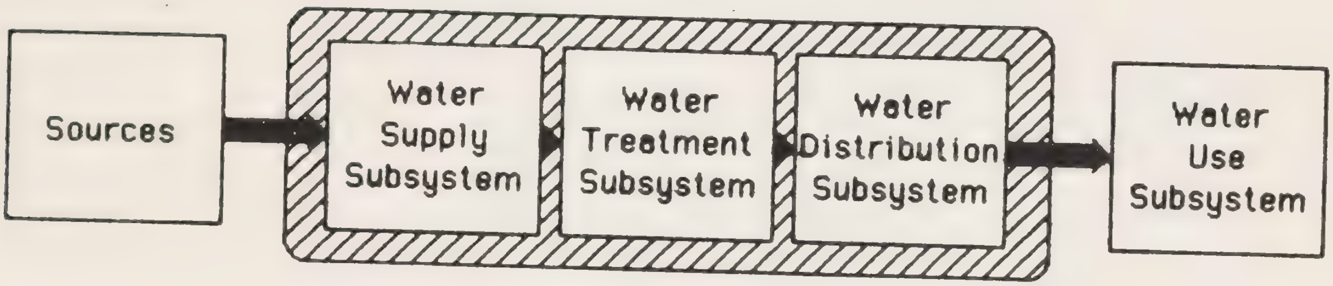
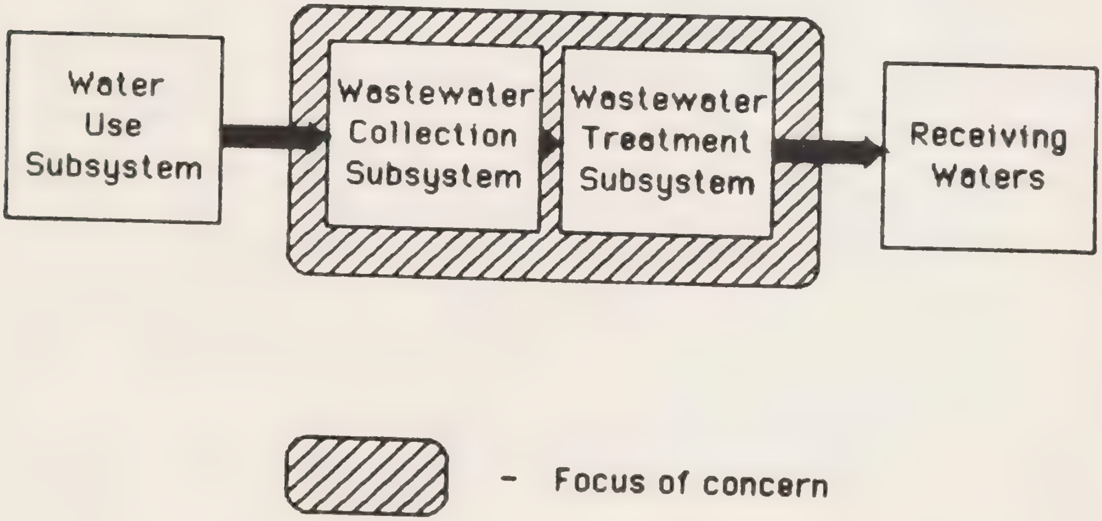
(a) Water



(b) Wastewater Treatment



decrease. Demand management also may apply to water supply or to wastewater treatment.

In the system described above, water demand management would focus on decreasing flow in the water distribution and use subsystems, and a demand management approach to wastewater treatment would have a similar focus on the use and wastewater collection subsystems (Figure 1.2).

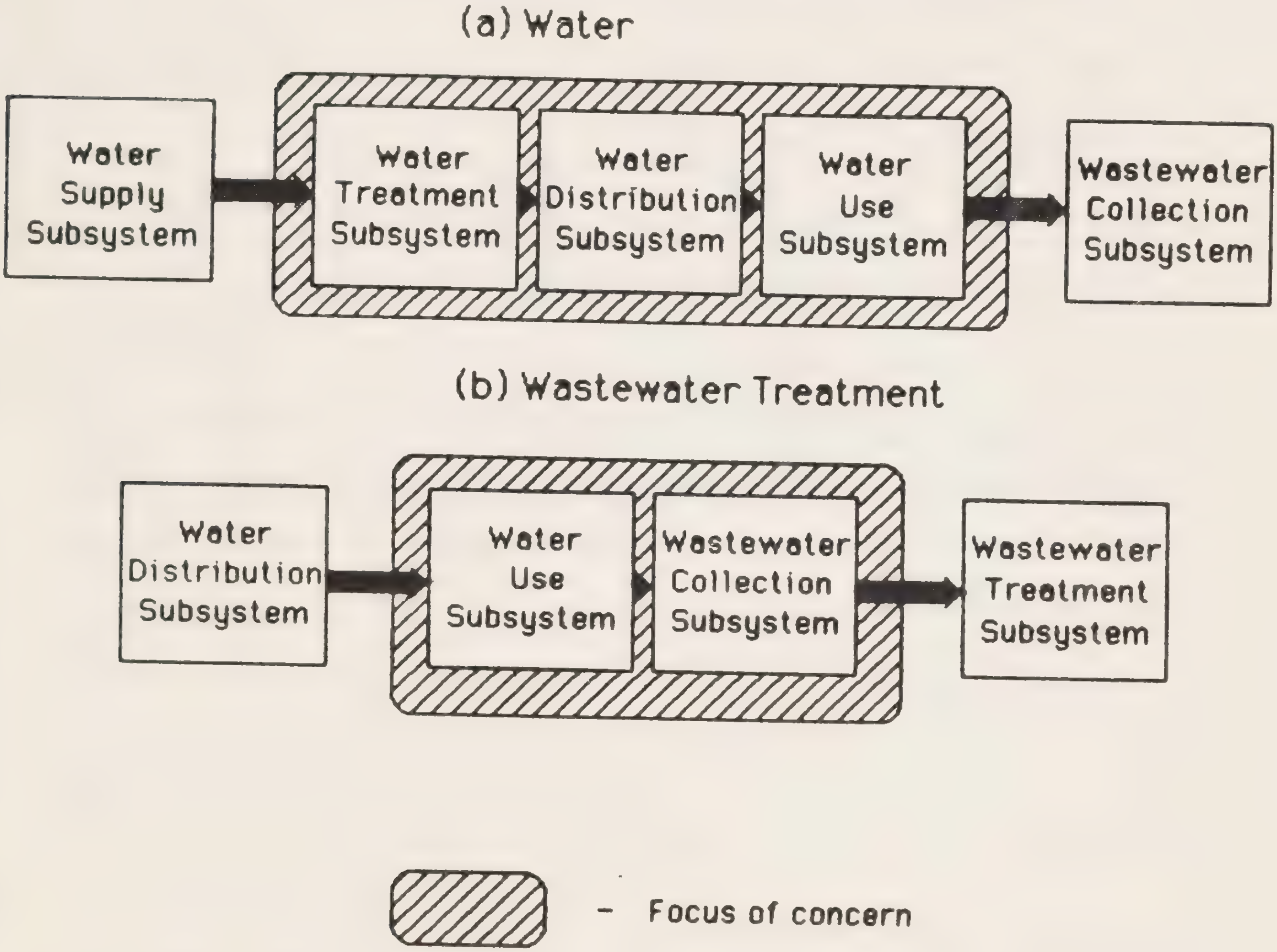
Managing water demand, however, requires development of policies (explicit or implicit) on appropriate use of the water system. (Supply management also requires such policies but these are often implicit.) Even an apparently straightforward policy of cost recovery can have significantly different results depending on what costs are recovered and from whom. Griffith (1984) illustrates application of a policy of recovering costs of providing for peak demands from users contributing to those peak demands; the system requirements with such a policy appeared reduced by about 12.5 percent over the previous policy of averaging peak demand costs into overall water rates. Augmenting supply by an equivalent amount would have been much more costly.

1.3 Why Consider Water Demand Management?

1.3.1 Inavailability of Short Term Supply

Managing water demand has traditionally been used primarily to meet critical water shortages (Viessman and Welty, 1984 p. 233). Most such crises have been a result of a severe drought which had strained the supply system to the point that all requirements (including emergency reserves) could not be filled.

Figure 1.2: Demand Management System



While some people view demand management and crisis management interchangeably, there are many factors other than crises which favour water demand management: these in most cases are of a longer term nature.

1.3.2 Inavailability of Longer Term Supply

(a) Physical Quantity

On a per capital runoff basis, Canada has the most water wealth of any nation, with over 100,000 m^3/person and over 13 times the world average (Postel, 1984, pp. 9-10). However, by the year 2000 at least some river basins in the Prairies may be unable to meet dry-year demands. Even the Great Lakes basin is not secure. An investigatory board of the International Joint Commission has predicted that Great Lakes levels may be lowered by 12 to 23 centimetres over 40 years as a result of increasing consumption.

(b) Physical Quality

The quality of available additional supplies may also be of concern. Stretching existing supplies may be particularly desirable in such cases.

(c) Increased Preservation of Other Uses

In recent years, there has been greater recognition of the value of and the need to protect in-stream uses of water--not just plant and fish growth, or dilution and purification, but also aesthetics, and to protect aquifer levels. At the same time, concern for preservation of other uses of reservoir sites has intensified.

(d) Political and Institutional

Problems related to social, political and institutional questions appear to have increased, especially where interbasin transfers of water are involved.

1.3.3. Cost

Because demand management has been considered less frequently, the total costs, both economic and environmental, may be less in many cases to manage demand than to augment supply, e.g. recovering costs of providing for peak demands mentioned in section 1.2.2.

A significant portion of cost savings may arise from deferral or scaling down of capacity expansions of plants, and from energy and chemical costs related to pumping and treating water. El Paso, Texas, found that besides reducing strain on aquifers, conservation (pricing and education efforts) is expected to meet 15-17 percent of long-term water needs, and has been doing so for an average cost of 135 dollars per 1000 cubic meters--8 percent less than the average cost of existing water supplies (Postel, 1984, p. 46).

1.3.4 Predicted Declines in Population Growth Rates

Another reason to consider demand management is that recent Canadian population projections indicate an increase until the turn of the century only, and after that period of time it could even begin to decline unless immigration levels are significantly increased (Statistics Canada, 1984). The implication of this is that while some municipalities will experience continued growth, others will grow slowly and then decline. Some must be expected not to grow at all. Such statistics raise questions about the longer term desirability of many water facility capacity additions

which may be proposed, at least in the absence of a national population policy.

1.3.5 Public Attitudes

Public attitudes appear generally very favourable toward water conservation measures. In a survey of 1383 households in both humid and semiarid regions, 86 percent perceived the need to conserve as moderately important or very important (Baumann et al., 1984). Even on the use of reclaimed water, except for uses related to direct ingestion, six studies have shown opposition to 25 uses of reclaimed wastewater to be consistently less than 40 percent; if indirect ingestion uses (e.g. swimming) are removed, opposition is less than 25 percent (Bruvold, 1985, p. 133).

1.4 **How should Demand Management be Integrated**?

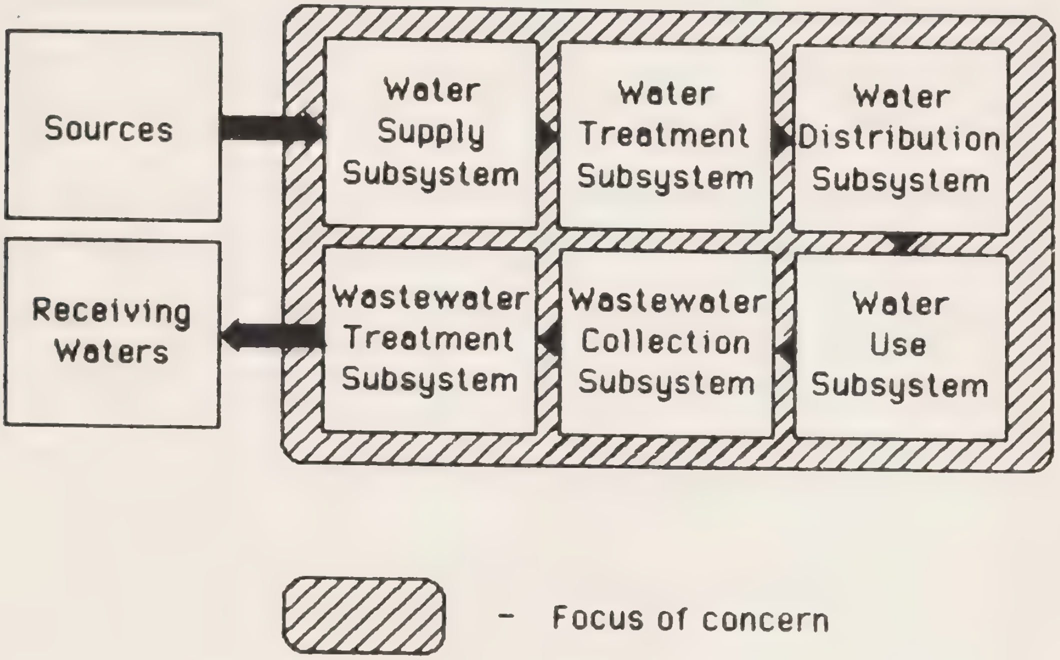
1.4.1 Integrating Supply and Demand Management

If the goal is efficient water system management, neither supply management (section 1.2.1) nor demand management (section 1.2.2) alone are satisfactory. While there is some overlap, each considers a different set of subsystems as of primary importance. While supply management often emphasizes additional large-scale capital projects, demand management options are often either many smaller scale changes or policy modification. A better approach to water system management is to integrate supply and demand management. This is illustrated in Figure 1.3 for water and for wastewater treatment systems.

1.4.2 Integrating Water and Wastewater System Management

It can also be noticed from the discussions of demand management, and from Figure 1.3, that consideration of managing demand has another implication. Once the use system's demand for water and generation of wastewater are not treated as given,

Figure 1.4: Integrated Water-Wastewater System



that two of the fundamental objectives served are (a) increased availability of water, and (b) improved economic efficiency or system optimality. These objectives are important in all sectors.

II EXISTING AND POTENTIAL DEMAND MANAGEMENT MEASURES: AGRICULTURE

The focus of this section is on identifying demand management measures which are currently in use or which could be used to reduce the rate of growth of water use in the agricultural sector. Both dryland and irrigation agriculture are considered.

2.1 Dryland

The agricultural community in Canada is taking a growing interest in dryland soil moisture management. This interest is particularly apparent in the direction of dryland cultural practices and in the increased emphasis on wetland management on agricultural lands, e.g. slough consolidation and supplemental irrigation.

The on-going changes in dryland cultural practices that will make more effective use of available moisture include the following:

- reduced summerfallow
- snow management to trap additional water for crops
- greater use of drought resistant crop varieties
- better farm management (eg: timing of operations)

(Canada Grains Council, 1982; dar Wall Consultants, 1983).

These changes will obviously not increase the overall availability of water for dryland agriculture. They will, however, make better use of the water that is available.

Drainage, again, does not affect the total water supply. Rather, the purpose of drainage is to redistribute water. The water may be channelled away from areas of excess to be used elsewhere.

2.2 Irrigation

Demand management measures are on-going in irrigation agriculture. The following takes many examples from irrigation in Alberta because of its prime

importance as an irrigating province.

2.2.1 Water Rights

Controls are already in place to limit the amount of land that can be irrigated. Agricultural lands are given irrigability classifications which effectively limit the extent of irrigation development and, hence, water use. In Alberta, private irrigators must obtain approval from Alberta Environment to divert water. These diversions are inspected every three to five years after the license has been granted in order to ensure that the water is being used according to the conditions set out in the license (Environment Council of Alberta (ECA), 1979).

However, because the number of hectares of potentially irrigable land greatly exceeds current development levels on the Prairies (by, say five times), water rights, as presently constituted, generally only serve to allocate water to agriculture at one point in time.

2.2.2 System Technologies/Design

Irrigation system design is obviously a major factor in water management. A brief description of common conveyance systems follows:

Open channel systems can be lined or unlined. Unlined canals are very inefficient with seepage losses often ranging from one-quarter to one-third of the total water diverted (Jensen, 1980).

Lining ditches is an effective way to prevent erosion, control rodent damage and reduce seepage losses at a reasonable cost. Concrete is probably the most commonly used material although asphaltic materials, membranes, chemical sealants and impermeable earth materials are also used.

The most efficient (and most costly) water conveyance system is pipe. Its main advantages are that water losses are negligible as are maintenance costs, and, if buried, a pipeline can take the most direct route from water source to outlet.

In Alberta, most canal rehabilitation is done using concrete lining although some pipe has recently been installed.

System configuration or layout is also important in a water management context. Assuming an open channel system, water losses due to evaporation, operational spills and the like can be significant (see Figure 2.1). Irrigation systems which follow field or quarter section lines, as opposed to the contours of the land, result in improved field work efficiencies, better weed control and more efficient water use.

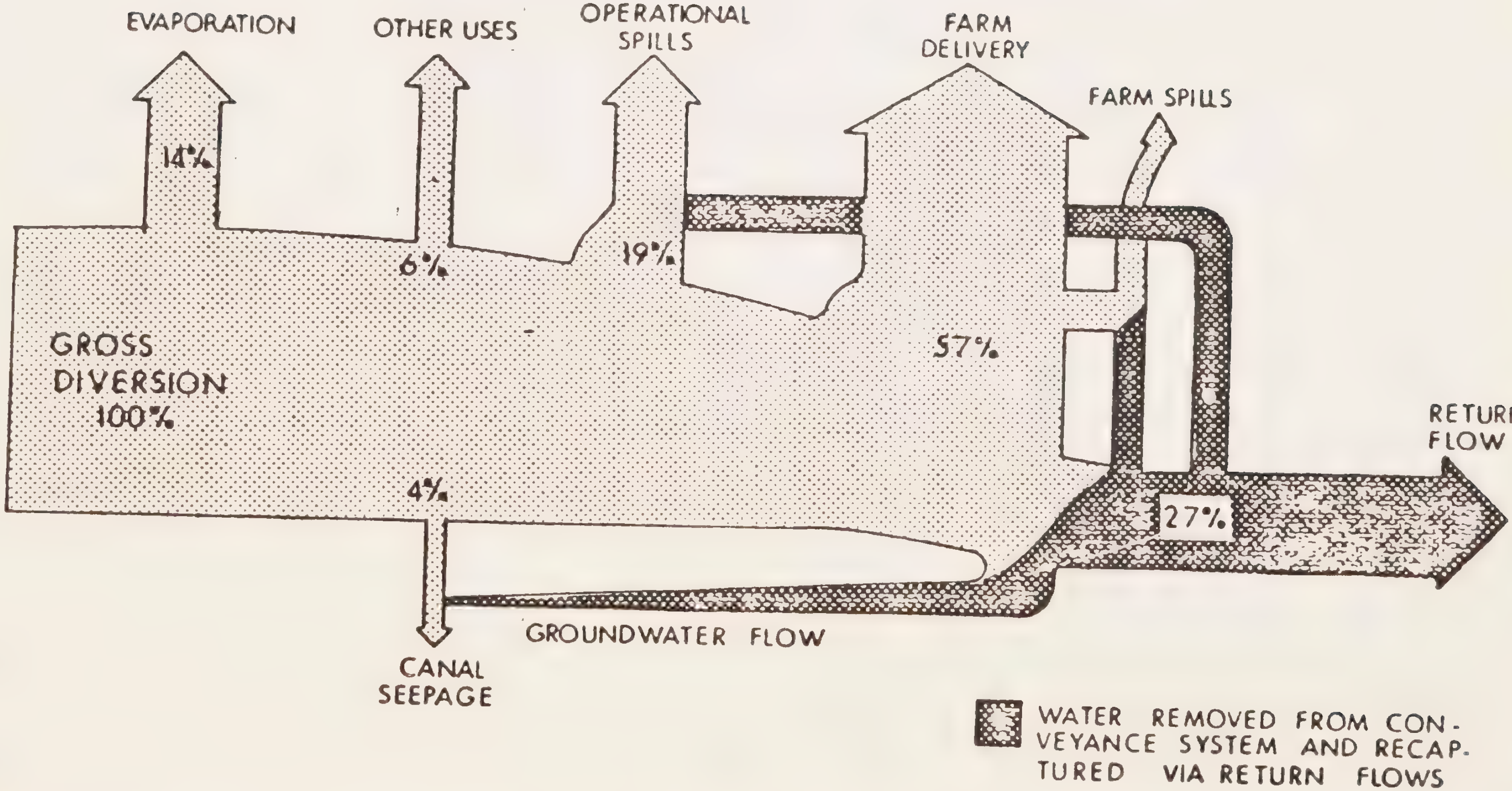
The "bottom line" in the whole question of delivery system design is irrigation efficiency levels. Estimates vary (Alberta Environment, 1982; ECA, 1979), but irrespective of source, it is clear that improving irrigation efficiency levels would play an important part in restricting the rate of growth of water use in agriculture.

And this is slowly happening. Millions of dollars per annum are now being spent on irrigation rehabilitation on the Prairies. These expenditures translate into higher irrigation productivity levels because more water is now reaching the farm gate.

2.2.3 On-Farm Technologies

Water use can also be controlled to some extent by the on-farm method of application. Flood irrigation for example, can be a low cost system but water may be nonuniformly distributed and erosion can be a problem. Wheel roll and center pivot systems (including low pressure sprinklers) offer greater control of water use but only by absorbing higher capital and/or labor costs. Drip irrigation is potentially the most

Figure 2.1
WATER USE IN IRRIGATION



NOTE: PERCENTAGE DISTRIBUTIONS BASED ON STUDY OF EASTERN IRRIGATION DISTRICT.

Source: Alberta Environment (1984) <u>Summary Report, South Saskatchewan River Basin Planning Program</u> Planning Division, Calgary

water efficient system because a relatively small area is wetted, thereby reducing evaporative losses and runoff (Jensen, 1980). However, problems of clogging and the fact that drip systems have no advantage over conventional systems for many crops (e.g., forages, cereals) suggests that drip irrigation is unlikely to completely replace other irrigation methods, despite its efficiency advantages.

Other on-farm technologies which could serve well to reduce water use include the selection of crop varieties that are more resistant to dry conditions and improved control of phreatophytes (water-loving weeds) by means of herbicides.

2.2.4 Scheduling

Improved water management is also possible by irrigation scheduling; both system and on-farm. The benefits of scheduling at the District level are substantial and include:

- more efficient use of water conveyance and distribution systems;
- reduced diversion and pumping requirements;
- reduced probability of system shutdown due to water shortages (ECA, 1979).

With scheduling, more water is available for irrigation. Design criteria for the system can be reduced because water is distributed more efficiently. Further, by matching water supplies to farm demand less water is spilled and salinity problems can be reduced.

On the farm, the scheduling of irrigation water to correspond to farm demand will result in yield and quality improvements. In addition, there is a reduced requirement for drainage and subsequent disposal of saline water.

2.2.5 Pricing

The price presently charged for water for irrigation across Canada is generally tied to the cost of various irrigation services, not the water itself.

For example, in Alberta the basic cost of water to both Irrigation Districts and non-District irrigators is the cost of obtaining a license from Alberta to divert water. These costs ostensibly represent the cost of processing a license application, and are dependent upon the annual quantity of water diverted as indicated following:

1 - 100 acre feet	- $1 for each 10 acre foot increment
101 - 1,000 acre feet	- an additional $5 for each 100 acre foot increment
1,001 - 10,000 acre feet	- an additional $5 for each 1,000 acre foot increment
10,001 - 20,000 acre feet	- an additional $10 for each 1,000 acre foot increment
20,000 acre feet - up	- an additional $5 for each 1,000 acre foot increment

In turn, Irrigation Districts generally finance their own operations by charging individual irrigators for water. Again, the charge is for the service, not the water itself. Individual Districts have a variety of methods of charging for water but each District has a basic levy charge which is based upon assessed irrigable area within the District (Table 2.1). Assessed irrigable area is that area suitable for irrigation to which the irrigation district has provided water service. The individual irrigators are charged the annual levy whether they irrigate or not. Districts also have a variety of other methods of charging for water including "final water agreements", "special water agreements", "terminable water agreements", and "pumping agreements". Outstanding rehabilitation requirements, however, suggest that the farm levies have been insufficient to cover required system maintenance.

The rehabilitation of existing irrigation works (in Alberta) is funded in the following way: The upgrading of the reservoir, division and headworks system is almost entirely the responsibility of the provincial government. Upgrading of the water distribution system is a cost-shared program with 86 percent funded from government sources and 14 percent from farmers' contributions (Underwood McLellan, 1984). The 14 percent share, while seemingly small, commits farmers financially to the process of improving water use efficiency through existing system improvements.

2.2.6 Metering

As noted above, each Irrigation District generally has a basic levy charge which is based upon assessed irrigable area within the District. The charge effectively guarantees the irrigator at the farm gate 1.5 acre-feet per acre of water throughout the irrigation season (Environment Canada (EC), 1977). This guaranteed gross diversion is the extent to which water use is now metered. More efficient water use would result if the levied price was based on the quantity of water actually used rather than a fixed volume (ECA, 1979).

2.2.7 Public Information

Finally, a good example of the type of public information program which can be very useful from a water demand management perspective is the South Saskatchewan River Basin Planning Program. The purpose of the SSRBPP was to develop criteria to evaluate various possible water use alternatives using a multiple use, multiple objective approach. The real value in the SSRBPP study (and others like it) is that it clearly identifies the water use options available (e.g. irrigation versus recreation versus industry) and the tradeoffs that are required once a certain water use option is selected.

Table 2 1

ALBERTA AND B.C. - AGRICULTURE IRRIGATION DISTRICT WATER RATES PER HECTARE

(18" gross diversion)

Year	Alberta													B.C.
	St. Mary River	McGrath	Raymond	Taber	Western	Eastern	Bow River	Mountain View	Leavitt	Aetna	United	Lethbridge Northern	Ross Creek	S.E. Kelowna
1940	2.47	3.09	1.11	2.22	1.23	3.95	3.71	0.74	---	---	1.24	3.09	---	36.08
1960	3.34[a] 4.94	6.18	2.47	6.18	3.09	5.93	4.94	1.23	n/a	---	2.10	4.94	2.47	52.51
1970	5.68[a] 8.16	6.18	3.09	7.41	4.98	6.67	7.41	1.48	3.09	2.47	3.09	7.41	2.47	56.98
1980	20.26	12.36	14.21	18.53	12.36	12.36	12.36	4.94	9.27	4.33	6.80	19.77	6.18	123.55
1984[b]	29.64[d] (12.00)	14.82 (6.00)	16.06 (6.50)	27.17 (11.00)	16.67 (6.75)	17.29 (7.00)	24.70 (10.00)	12.84 (5.20)	19.76[c] (8.00)	14.82 (6.00)	8.03 (3.25)	30.88 (12.50)	7.41 (3.00)	n/a

[a]SMRID-W and SMRID-E respectively.

[b]Per acre rates indicated in brackets.

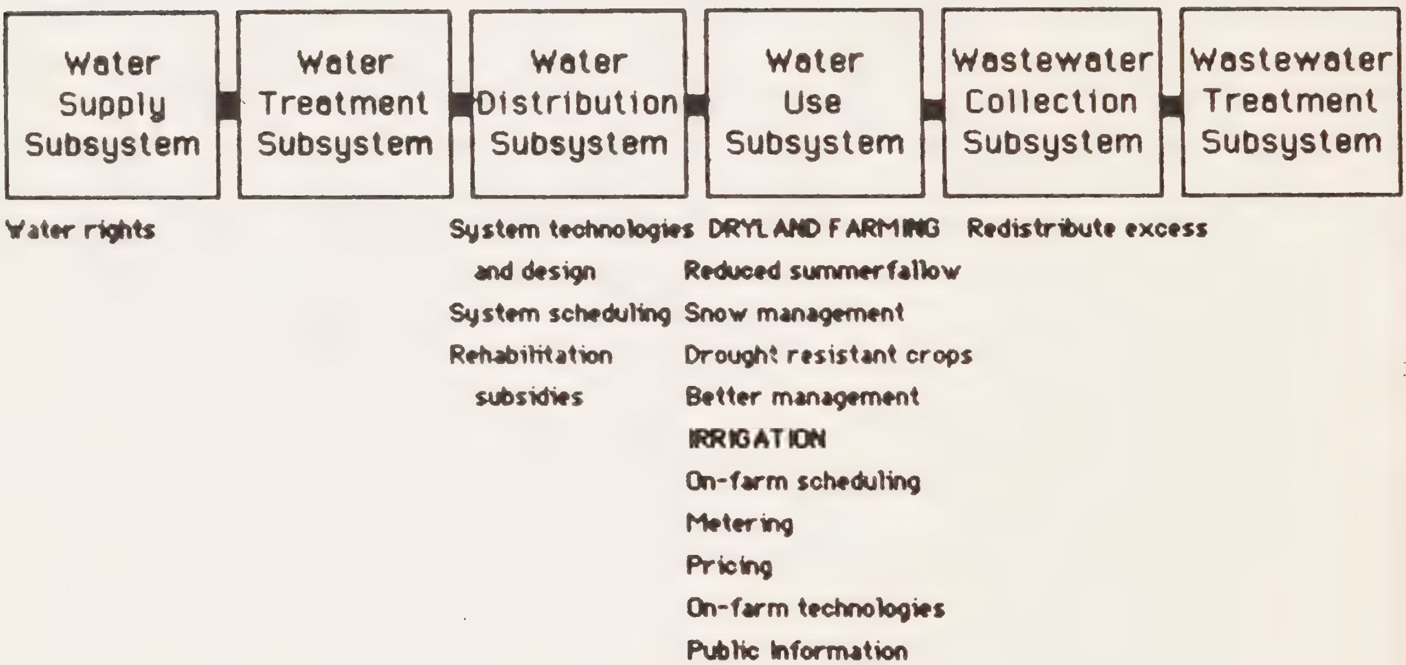
[c]Plus a $4.94/ha annual levy for farmers with a pipeline.

[d]Plus a $43.47/ha annual levy for farmers with a pressure pipe system.

2.3 Summary of Agricultural Measures

The measures discussed above are summarized in Figure 2.2. The principal component of the water system on which the measure is targetted is noted. The implications of some of the apparent options and opportunities are addressed in Section IV.

Figure 2.2: Summary of Agricultural Measures



III EXISTING AND POTENTIAL DEMAND MANAGEMENT MEASURES: MUNICIPAL AND INDUSTRIAL

The focus of this section is on identifying measures which are currently in use or which could be used to manage municipal and industrial demand for water and for wastewater treatment. These will be discussed taking each part of the water system in turn.

3.1 **Water Supply and Treatment Subsystem**

3.1.1 Direct Regulation of Source Withdrawals

Managing source withdrawals can occur through regulation of access. One example from western Canada is the use of rights to water withdrawals. Another example in a riparian province, Ontario, is that the Ministry of the Environment requires an approval for supplying more than five homes or a permit for withdrawing more than 50,000 litres/day of groundwater.

However, such regulations can only work well for supplies which are documented. While much measurement of water supply has been done, mapping of groundwater systems has been generally overlooked. Such mapping would greatly improve management capability.

3.1.2 Matching Water Quality and Use

Estimates of demand for water are based for most uses on a presupposition about water quality. There is no need to use potable water for all water purposes. This principle is recognized for households in many areas in the United Kingdom: a storage tank is required in the roof space to feed non-potable supplies such as toilets, hot water cistern, etc. to reduce the effects of peaking on the distribution network

(Jamieson and Million, 1980). Brackish water or saltwater is beginning to be used for cooling of power plants in Finland, Sweden, the United Kingdom, and the United States (Postel, 1984, p. 46). South African water policy specifically calls upon all users to "make use of the minimum quantity of water of the lowest acceptable quality for any process" (Postel, 1984, p. 46). Such an approach in Canada could reduce the demand on existing water systems by transferring some uses, which currently use high quality water, to non-potable supplies.

3.1.3 Public Cost Information

While most municipal water supply systems, including those which are metered, charge on an average cost basis, the system itself must be constructed to meet maximum-day and peak-hour demands, not just average demands. Maximum-day demands from 1.5 to 3.5 times average-day demand, and peak-hour demands from 2.0 to 7.0 times average-day demand, are quite common (Fair and Geyer, 1971). Therefore, the capital and operating costs involved in providing for peak demands are much higher than for average-day demands. Because charging currently is done on an average-cost basis, the cost of providing for maximum-day demands is often not estimated and less often public knowledge. Information about such peaking costs and also of incremental average-day demand costs, if provided to the public and to policy-makers, could assist in improving decisions about use.

3.2 **Distribution Subsystem**

3.2.1 Proper Installation, Leak Detection, and Maintenance

In areas where freezing and soil movement is a problem, careful installation of distribution lines is necessary. Leakage losses from the distribution system, while inevitable, can be minimized through a routine maintenance and leak detection

program (Hennigar, 1984; Kroushl, 1984). A California study found that almost 99 percent of underground leaks in urban water supplies could be economically detected and recovered using existing technology (State of California, 1984, p. 31). This contrasts rather sharply with findings of the Prairie Provinces Water Demand Study that in some municipalities, over 40 percent of total water pumpage could not be accounted for by flows received by the various customer groups (Tate, 1984, pp. 5-6).

3.2.2 Regulation of Water Pressure in New Development

Operating water pressures in a municipal system are generally between 345 and 834 kilopascals (50 to 120 psi) with an objective of 140 kpa (20 psi) under fire flow conditions. Reducing high main pressures would lower consumption for flow dependent uses, as water flow rate from a fixture at a fixed setting is related to the square root of the pressure drop. Principal flow dependent uses at fixed settings include system leakage, certain types of equipment e.g. residential dishwashers, and some outside uses.

However, substantial reduction of main pressure in existing areas may not be practical because of the implication of reduced fire flow. In new development, an attempt to limit water pressure to 345 to 420 kpa (50 to 60 psi) would reduce both leakage and use somewhat. The HUD studies suggest the reduction in residential use for a drop of 205 to 275 kpa (30 to 40 psi) would be about 6 percent (U.S. Dept. of Housing and Urban Development (USHUD), 1984).

3.3 Water Use Subsystem

3.3.1 Metering of Use

While many studies of metering have been conducted, few have separated

commercial, industrial and residential users within one city or district over the same time period. The HUD study, however, attempted to determine the effect of metering on residential water use by comparing water use in similar homes in the same area of Denver having had metering or flat rates for some time (USHUD, 1984). Winter water use showed little difference, but summer metered consumption was reduced significantly even though annual water costs were similar for both classes. Metered outside water use over a three-year period was reduced by 20 percent.

In addition, outside water use in both metered and flat rate homes was linearly related to the monthly net evapotranspiration (water requirement in addition to rainfall) of the vegetation.

3.3.2 Water Rate Structures Better Reflecting Costs

Water rate structures are a very important component of demand management. Such structures are possibly the most important influence by a supplier on industrial water demand. It is difficult to convince many water users that water use is important or that new water supplies are costly when their water bills confirm the exact opposite. Effective rate structures, however, presuppose installation of water meters (section 3.3.1).

Grima (1984) showed that water rates in Ontario in the recent past have not been related well to costs of providing supply. Nevertheless, a rate structure should closely reflect the costs of construction, operation and maintenance of the entire system, including peaking costs and the costs of wastewater collection and treatment.

This was done, except for reflecting peak demand costs directly, in the Regional Municipality of Durham. A 33 percent reduction in demand per customer and hence in water supply capacity requirements was observed (Loudon, 1984).

However, the factor not reflected directly in the Durham rate structure, peak demand, is perhaps the most important factor affecting costs. Such demands determine plant sizing and additions, and also are responsible for large electrical power demands and costs. Costs of providing for peak demands have traditionally just been averaged in with other costs by customer class. This results in inequity, both by not informing those contributing to the peak of the real costs of their use, and by charging those not contributing to the peak demand.

Recently, however, a number of utilities in the U.S. have modified rate structures to improve equity and, at the same time, to charge a better approximation of the real costs of providing for peak demands. One of those found to significantly improve equity is referred to as an excess-use charge, incurred by water users greatly exceeding their winter base consumption during peak demand months. Use of such a charge in Fairfax County, Virginia, was estimated to reduce maximum-day water demand by about 12.5 percent from 1.6 times average-day to 1.4 (Griffith, 1984).

3.3.3 Constructing New Structures to be More Water-Efficient

(a) Installation of Low-Flush Toilets

While common toilets use about 21 l. per flush, major North American manufacturers do market models requiring 13.25 l. or less. A recent extensive study showed that households equipped with such low-flush toilets consumed about 30.3 l/capita/day less than those with standard toilets (USHUD, 1984, pp. 4-5, 4-6). This represents a 36 percent reduction in consumption.

A typical West German toilet requires much less water than even our so-called conserving ones, only 9 litres per flush, or a 57 percent decrease in consumption over conventional North American models (World Environment Report, 1984a). Nine litre

toilets have also been legislated for many years in the United Kingdom (Jamieson and Million, 1980).

(b) Installation of Low-Flow Showerheads

The HUD sample of typical non-conserving showerheads (maximum measured flow greater than 11.4 l/min.) had an in-use average flow rate of 12.9 l/min. This was much higher than for a mixed set of low-flow showerheads which averaged 44 percent less, with some specific models reducing consumption by 62 percent.

(c) Installation of Minimal-Water-Use Toilets and Showers

New products have been developed using advanced technologies which reduce water consumption significantly more than those discussed above. There is a good potential for development of such products which cut water demand substantially and are acceptable to users. This is especially so for toilet technology; showering is partially a volume dependent activity, and very low flow rates cause user dissatisfaction. Currently, however, advanced technology fixtures are much more costly and complex than conventional ones.

(e) Installation of Combinations of Water-Efficient Equipment

In many areas in the U.S., plumbing regulations require installation of water-efficient equipment in new homes. A recent HUD study compared water use in homes containing 13.25 l/flush toilets, 11.4 l/min. showerheads, and low flow (10.4 l/min.) faucets, with a matched control group in the same vicinity. The HUD study recommends the expected water savings they have documented--49 l/capita/day and 62 l/capita/day for single and multi family dwellings respectively--be adopted as predicted values for the effect of installation of low-flush toilets and low-flow

showerheads on per capita residential water use.

3.3.4 Retrofitting of Existing Buildings

(a) Reducing Functional Consumption

Modification or retrofitting of water fixtures to reduce water consumption has been attempted in many municipalities, especially in the United States. The effects of such programs have not been well documented, and most evaluations which do exist are of one specific municipality. After the Regional Municipality of Waterloo, the HUD study was the second, and largest scale attempt to document effects of retrofitting and relate these to the context and to the implementation program.

There are two primary factors to be considered: the effect of retrofitting on resource consumption, and the installation/retention rates of the devices.

i) Resource Consumption

Utility programs to retrofit toilets with displacement bags or bottles, and showers with flow restrictors are estimated to reduce water consumption by 15 to 25 l/capita/day and energy consumption/capita by 420 to 630 MJ (11.4 to 17m^3) annually for gas water heaters (HUD, 1984, p. 6-5). Greater reductions should result either from use in toilets of dams or of devices to close the flapper valve prematurely (about 4.5 l/capita/day more for dams) or from use on showers of replacement showerheads. The savings noted are those estimated from retrofit devices alone; controls were used for extraneous factors and an allowance was made for other components, e.g. leak detection tablets, conservation information, of some programs.

(ii) Installation/Retention Rates

The installation and retention rates of the devices are also important in assessing a retrofit program. There are many factors which determine the extent to which installation of retrofit devices takes place. Some of these include:

(1) the perceived importance of the program in extending existing water supplies or wastewater treatment capacity,

(2) whether installation was voluntary or mandatory,

(3) how the program was promoted and the devices distributed,

(4) whether installation was conducted by utility or trained personnel or by the owner, and

(5) if by the owner, the ease of correct installation.

Retention rates are related to all of the above as well as to:

(6) satisfaction with device performance.

(7) failure rates of each device, and

(8) the rate of purchase of replacement fixtures.

It appears that installation rates in residential buildings can range all the way up to about 80 percent in single family buildings and 100 percent in multiple dwellings (including motels) for a mandatory program with utility installation (HUD, 1984, p. 6-6). There is no evidence that a voluntary program can achieve greater than a 60 percent installation rate with 50 percent a more realistic maximum under non-drought conditions.

For any one device, it might be expected that retention rates would be constant. Only two studied utilities, North Marin County and North Tahoe California, used an identical device and evaluated retention rates. Surveys concluded that the 11.4 l/min Nolan celcon shower restrictor had a five-year retention rate over 80 percent in each

case. Different toilet devices had 5-year retention rates in houses ranging from 59 percent (dams-North Tahoe) to about 77 percent (2 bottles each 0.95 l., 1 bag 2.7 l.).

(b) Reducing Leakage

Retrofitting of apartment buildings has also been studied in the Washington D.C. area. Toilet leakage appears to be a major problem; even in some new buildings, the rate averaged 178 l/day/unit, or 91 l/day/toilet. (In a separate study of single family homes, 17 percent of non-conserving toilets were found to be leaking. This percentage might be even higher when low-flush toilets are used or in apartment buildings).

Replacing ballcocks and flapper valves is the best method for correction of toilet leakage. This measure alone was found to reduce residential consumption by up to 178 l/day/unit or 89 l/capita/day, or by over 40 percent.

3.3.5 Regulation of Water Pressure

Although the saving was lower than previous estimates, a reduction of 205 to 275 kpa (30 to 40 psi) would reduce residential leakage and use about 6 percent, according to the HUD studies (see section 3.2.2 above). This reduction could be accomplished by use of pressure regulating valves in buildings in high pressure areas. Such a measure could be implemented most easily for new developments in high distribution pressure areas where the distribution pressure cannot be reduced; existing low rise developments could also install pressure regulating valves. These valves, by regulating water pressure, can reduce wear on water fixtures and thus maintenance costs as well.

3.3.6 Use of Insulated and Heat-Traced Services

The use of "bleeders" (continuously flowing lines) to prevent line freezing results in major losses for water utilities in northern communities and increases demands on wastewater treatment plants. Ontario Ministry of the Environment reviews have found bleeders responsible for up to 50 percent of winter potable water consumption. The proper solution is use of insulated and heat-traced services (Robinson et al, 1984).

3.3.7 Recycling of Wastewater

Recycling means use by the same household, business, or plant two or more times in a coordinated planned manner, sometimes with partial treatment between uses (Viessman and Welty, 1984, p. 241). The lowering of energy costs for pumping, water heating, and wastewater treatment may be more significant than the reduction in water cost by recycling.

(a) Residential

By collecting blackwater (toilet water waste) and gray water (other wastewater) separately, the graywater in principle can be reused before being used finally for lawn irrigation or being disposed of via the sanitary sewer system. Such re-use raises many serious concerns about the effects on the health of humans and landscapes (Farallones Institute, 1979, pp. 97-109).

(b) Industrial

Significant advances have been made in the recycling capabilities of cooling tower recirculation systems: the average recycle rate for cooling water in 1972 was 4.1, but by 1978 this had risen to 7.1 with some companies claiming 27:1 (Viessman and Welty, 1984, p. 237). Thermal power plants can reduce their requirements by 98

percent or more by using recycled water in cooling towers rather than the typical once-through cooling methods (Postel, 1984, p. 42). A Canadian vinyl fabric manufacturer, by installing a cooling tower recirculation system, reduced total water consumption over 90 percent while increasing production by 60 percent (Krueger, 1984).

Other industrial recycling practices include treating some or all process wastewater for re-use as other process make-up water e.g. cooling towers, recirculation systems with discharge a low percentage of flow, and cascading effluent from one process as input for another with or without intermediate treatment (Viessman and Welty, 1984, p. 244). A Canadian heat exchanger manufacturer reduced water consumption by one-third, with a payback period of less than one year for the system modification (Paul, 1984).

The degree of recycling can affect water use tremendously. Manufacturing a ton of steel may take as much as 200,000 litres or as little as 5,000, and a ton of paper may take 350,000 litres or only 60,000. Moreover, recycling the materials themselves can also greatly cut industrial water use and wastewater discharges. Manufacturing a ton of aluminum from scrap rather than virgin ore, for instance, can reduce the volume of water discharged by 97 percent (Postel, 1984, p. 42).

On a national level, adoption of recycling technologies can have a major impact on water use. Israel's adoption of what amounts to a "best available technology" standard for industrial water use efficiency has reduced water use per unit value of industrial production by 70 percent over the last two decades. Sweden's industrial water use, primarily for pulp and paper, quintupled between 1930 and the mid-sixties; however, strict environmental protection requirements for the industry brought widespread adoption of recycling technologies, which, despite a doubling of

production, cut its total water use by half--a fourfold increase in water efficiency (Postel, 1984, pp. 42-43). The United States is expected to more than double pulp and paper production between 1981 and 2000, while reducing total water usage about 4 percent; use of developing technologies could reduce water usage another 28 percent (Wyvill, Adams, and Valentine, 1985). The exact potential for such technologies in Canada is not known; however, when other countries are reducing water use per unit of output by 75 percent in resource-based industries such as pulp and paper, and Canada is not a known leader in recycling efforts, there must be much room for increased water use efficiency.

3.3.8 Education

Education about water conservation and management is seen as desirable both by the public and by water experts (DeYoung and Robinson, 1984). In addition, many initiatives in this area have been taken.

Water system management materials suitable for Canadian school system environmental studies programs have been developed by the American Water Works Association (Bock, 1984). A water use index is currently published in the local daily newspaper by the Regional Municipality of Waterloo during summer months (Pawley, 1984). A number of utilities insert with water bills pamphlets on water use and on suggestions for conservation. Other education activities also exist. However, there is little documented evidence of the effects on water demand of such programs by themselves.

Part of the reason for this is that most education activities are undertaken as part of another specific project. In such cases it may be better to regard education programs not as measures which directly affect demand, but rather as both necessary

public relations activities and integral components of other specific management measures.

3.4 Wastewater Collection Subsystem

3.4.1 Reducing Infiltration

Wastewater collection and treatment systems are also designed to meet maximum day and/or peak hour demands. A major problem in meeting these demands is caused by extraneous flow. Extraneous flow may result from infiltration of defects by groundwater, or from inflow of surface and/or stormwater into the system.

Wastewater system expansions may be reduced through proper design, construction and routine preventive maintenance. Specific actions which can be taken include avoidance of areas of high water table for development, regular sewer inspection, and sewer relining or replacement (Benninger, 1984a; St. Onge, 1984).

3.4.2 Reducing Inflow from New Development

While it may be assumed that new development will have separate storm and wastewater systems, other measures deal specifically with connections of foundation drains, sump pumps or roof gutters to the wastewater collection system. Effective action consists not just of prohibiting such connections, but also of enforcing the prohibition. One measure which can be used where gravity connections to storm sewers are not practical is to require sump pumps draining weeping tile to be installed in all new residential construction, as has been done in Waterloo, Ontario; this reduces any temptation to make illegal connections to the sanitary sewer. Although enacted for a different purpose - drier basements, the policy of Cambridge, Ontario, to provide storm sewer connections to new residential development and to require

sump pump pits should have a similar effect.

New development in some communities is specifically designed to facilitate retention and percolation of stormwater, reducing the load on storm sewers and streams. Such practices help manage the demand for stormwater facilities.

3.4.3 Reducing Inflow from Existing Development

The other part of the problem is correcting existing connections, which were almost a standard practice for many years. Even in areas where they were technically illegal, they were regarded often as minor sins especially if committed when the building inspector was not present. Now, while legislation such as the Ontario Municipal Act gives them authority, municipalities have been reluctant to force homeowners to correct inflow problems caused by improper connections. Fort Erie, Ontario, however, has done so and gave property owners a choice of correction arrangements: dealing with a government-tendered contractor at a fixed price, negotiating with a contractor of their own choice, or having the city order the work done and billed through city taxes (Robinson et al, 1984).

3.5 **Wastewater Treatment Subsystem**

3.5.1 Costs

As effluent volumes and levels of treatment increase, wastewater treatment costs rise rapidly. Reduction of wastewater flows can reduce treatment costs significantly in three ways. Reducing the peak volume of effluent water processed can defer the capital costs of expanding existing facilities; in most plants, lower flow rates provide for increased efficiency of plant processes due to higher concentration of waste, and lower operating costs or improved effluent quality; and lower flows also

reduce untreated water overflows if or when the plant is overloaded. In the latter cases, the reduced costs are environmental rather than financial. Public cost information could assist.

3.6 Wastewater Re-use

Re-use refers to use by someone other than the original user, especially in an uncoordinated and random way (Viessman and Welty, 1984, p. 240). The water may be re-used without treatment where lower quality is acceptable, or may be reclaimed (treated for re-use) for the same or for a different purpose.

3.6.1 Direct Re-Use

For direct re-use, the wastewater is usually treated and then piped directly into a supply system.

The supply system could be one for potable water. The City of Denver has planned for direct potable re-use by the end of this century, has completed pilot studies, and is currently testing effectiveness and safety of a 1mgd demonstration plant and conducting studies on public attitudes and on appropriate methods of conducting a public education campaign (Lauer, Rogers and Ray, 1985; Lohman and Milliken, 1985). South African engineers estimate the cost of treating raw sewage to a quality suitable for drinking to be competitive with another surface source (World Environment Report, 1984b).

Reclaimed municipal water may also be appropriate for non-potable uses. One of the principal benefits of non-potable re-use is the preservation of higher quality water for potable consumption. Such domestic non-potable re-use effectively requires a dual distribution system for potable and non-potable water.

Re-use as cooling water and as boiler feed water are two principal industrial applications of reclaimed wastewater. For example, a nuclear power plant built in the desert outside Phoenix, Arizona, will draw on nearby communities' treated wastewater, which the plant will re-use 15 times (Postel, 1984, p. 42).

Re-use of municipal wastewater for irrigation has been endorsed by the Environment Council of Alberta to reduce deterioration of river water quality (ECA, 1979, pp. 66-67). Additional benefits include savings in energy, treatment costs, groundwater supply augmentation, and nutrient utilization, but some level of treatment of the wastewater may be necessary because of public health concerns. In 1981, Israel was already re-using 30 percent of municipal wastewater, mostly for irrigation, and by the turn of the century, projects re-using 80 percent (Postel, 1984, p. 47).

Studies in Alberta have shown irrigation from a sewage lagoon has had no marked effect on soil chemistry and no identifiable impact on groundwater (Alberta Environment, 1978). Feasibility studies are being conducted on piping treated sewage from Calgary to irrigate 100,000 acres in southern Alberta (Thompson, 1984).

Stormwater collected separately from wastewater can also be reclaimed for non-potable uses with appropriate physical treatment depending on the required quality; uses range from high quality steam boiler feedstock to industrial cooling to lawn irrigation, fire protection and landscape ponds (Viessman and Welty, 1984, p. 250-252).

3.6.2 Indirect Re-Use

With indirect re-use, one or more stages, e.g. discharge or mixing with another water supply, are inserted between treatment and re-use. A common and accepted

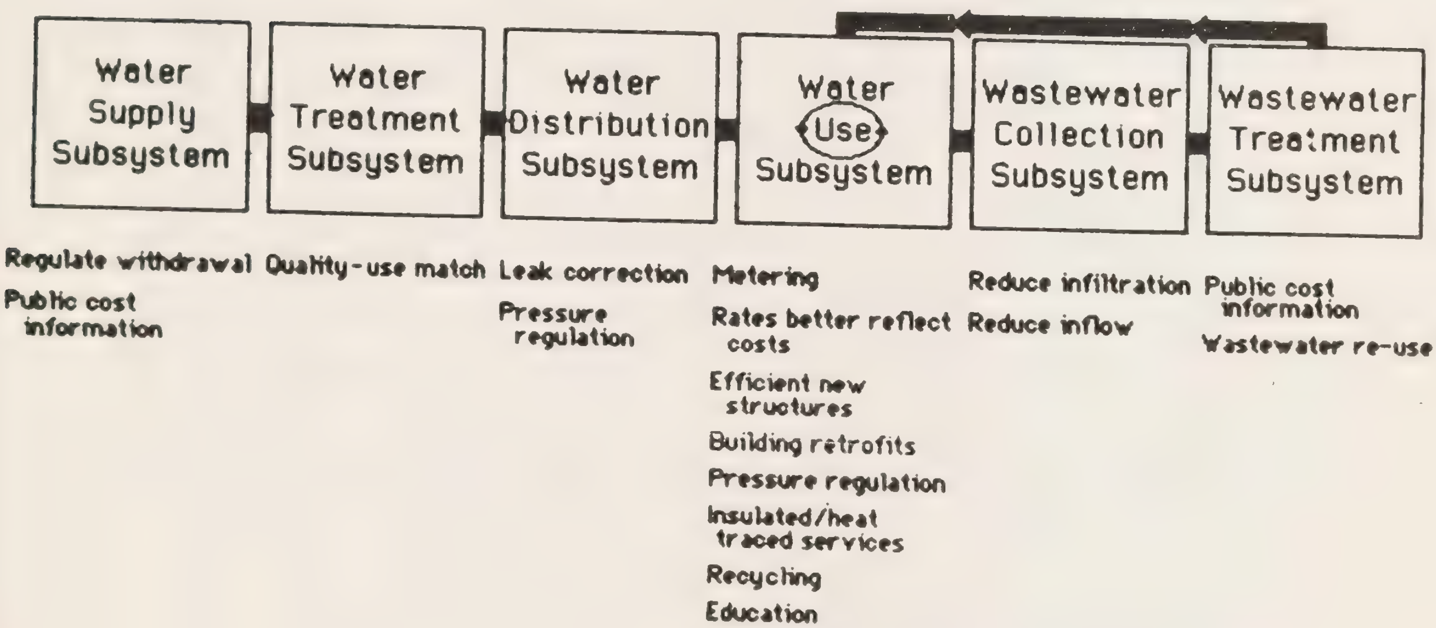
example of indirect re-use is that of water users with intakes downstream of a wastewater treatment plant discharge outfall.

Another example is the artificial recharge of groundwater aquifers with reclaimed water for storage, dilution, and later withdrawal and re-use. However, this form of re-use for drinking water is subject to the same concern as direct re-use: what chemical constituents are acceptable in potable water and in what concentration? High quality reclaimed water is already being stored in aquifers in California, but quality standards for potability have not yet been accepted (Viessman and Welty, 1984, p. 243).

3.7 Summary of Municipal/Industrial Measures

The measures discussed above are summarized in Figure 3.1.

Figure 3.1: Summary of Municipal/ Industrial Measures



IV WATER SYSTEM EFFICIENCIES: IMPACTS & IMPLICATIONS

4.1 Introduction

The potential importance of additional water use efficiencies in Canadian agriculture must be emphasized because

1. agriculture is the largest single consumer of water in Canada, particularly on the Prairies, and
2. the potential for major improvements in water use efficiencies in agriculture is still immense.

Further implications beyond those discussed above are provided for two other longer term approaches to managing industrial and municipal demand: matching water quality and use, and constructing new structures to be more water-efficient.

A summary of potential water use efficiency improvement potentials is provided at the end of the chapter.

4.2 Efficiency Measures: Agriculture

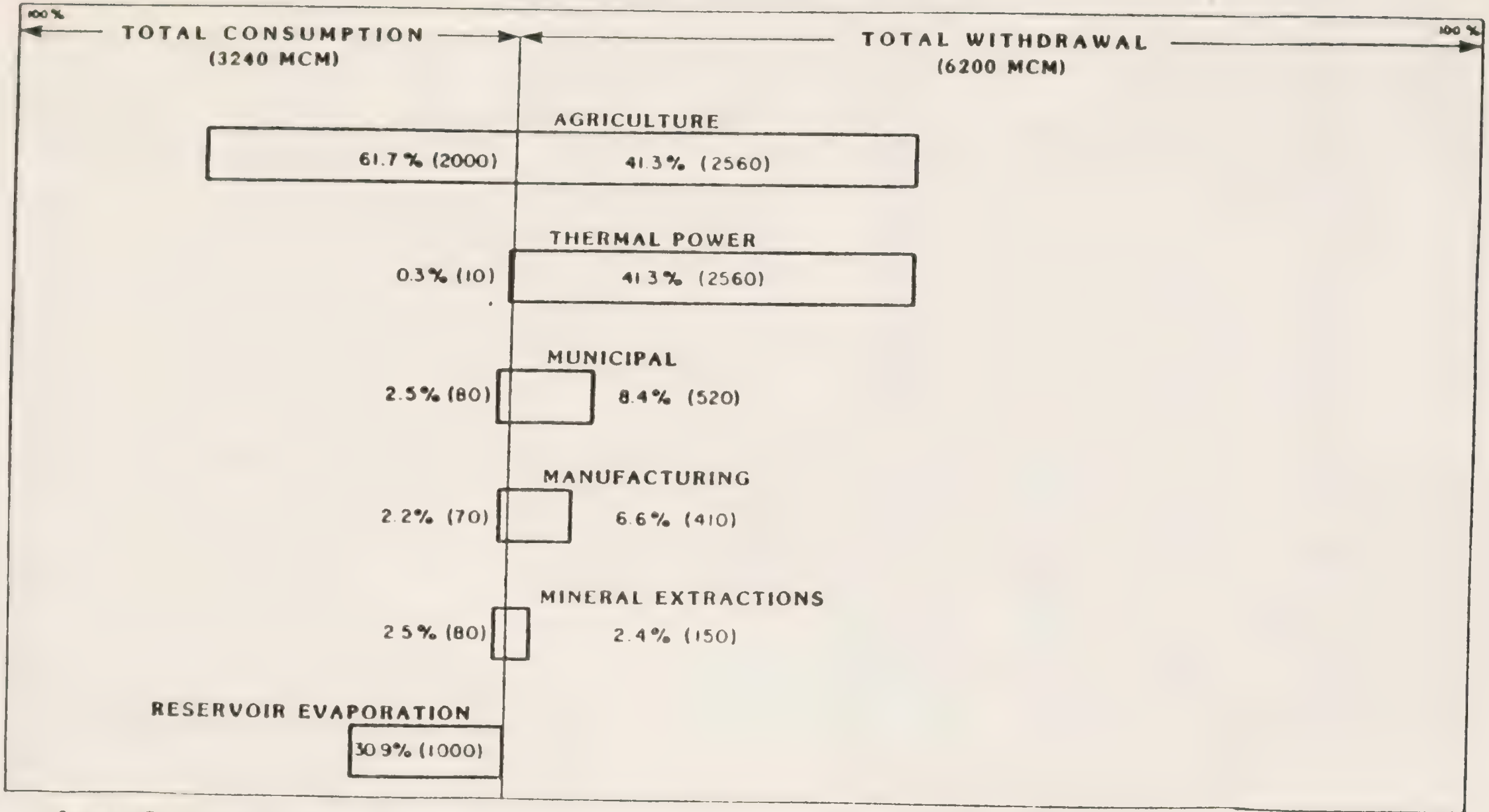
The dominant role of agriculture in both the withdrawal and consumption of water in Canada is illustrated in Figure 4.1 and accompanying Table 4.1.

The principal implications of increased water use efficiencies in agriculture are considered with respect to the following: (1) dryland cultural practices, (2) water rights, (3) delivery systems, both on-farm and off-farm, (4) scheduling, and (5) pricing and metering.

FIGURE 4.1

WITHDRAWAL AND CONSUMPTIVE USES IN THE PRAIRIE REGION, 1981

(million cubic metres)



Source: Environment Canada, Submission to the Inquiry on Federal Water Policy, Regina, 1984.

4.2.1 Dryland Cultural Practices

Many on-going changes in dryland cultural practices are having an obscure but very real impact on water use and, hence, groundwater levels and streamflows. These changes include shifting cropping patterns, tillage practices, harvesting technology, fertilizer practices, weed control practices, and crop genetics. The projected qualitative impact of these measures on water use during the next 15 years is indicated in accompanying Table 4.2.

Shifting cropping patterns, particularly away from summerfallow, are, however, very dependent upon relative prices and marketing opportunities[1] (Ed Braun, Pedocan, and Marv Anderson (Ed Braun et al), 1984).

The role of water management in dryland agriculture is particularly important because its impact could be so pervasive: very, very modest improvements in dryland water use efficiencies on almost 40 million hectares of cropland and 155,000 farms on the Prairies would, in addition, reduce on-going soil degradation on the Prairies yet still increase its drought-proofing capability (Ed Braun et al, 1984). (Compare Table 4.3 with Table 4.4)

Facilitating changes in dryland cultural practices might be a particularly attractive water demand management strategy because the public cost of these water-saving technologies is relatively low. The public research expenditure required to develop drought-tolerant crops is an obvious exception.

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[1] In this context, there is still the age-old controversy over the "bias" in the Canadian Wheat Board market delivery system which, to some extent, still considers summerfallow a crop in its quota acreage calculations.

TABLE 4.1

WITHDRAWL AND CONSUMPTIVE USE OF WATER, CANADA, WESTERN CANADA, PRAIRIES, AND BRITISH COLUMBIA, 1980

(millions of litres per day)

Withdrawal	Canada	Share of Total Use (%)	Western Canada	Share of Total Use (%)	Prairies	Share of Total Use (%)	B.C.	Share of Total Use (%)
Municipal & rural domestic	12,410	11.1	2,815	10.9	1,739	10.6	1,076	11.5
Manufacturing	38,156	34.2	6,502	25.3	860	5.3	5,642	60.3
Mining	4,443	4.0	2,616	10.2	2,339	14.3	277	3.0
Agriculture	8,296	7.4	7,446	28.9	5,878	35.9	1,568	16.8
Thermal	48,400	43.3	6,344	24.7	5,557	33.9	787	8.4
TOTAL	111,705	100.0	25,723	100.0	16,373	100.0	9,350	100.0
Consumption								
Municipal & rural domestic	2,075	22.5	752	13.8	470	11.5	282	20.7
Manufacturing	1,567	17.0	381	7.0	154	3.8	227	16.7
Mining	792	8.6	574	10.6	465	11.4	109	8.0
Agriculture	4,409	47.9	3,678	67.7	2,941	72.2	737	54.2
Thermal	364	4.0	48	0.9	42	1.0	6	0.4
TOTAL	9,207	100.0	5,433	100.0	4,072	100.0	1,361	100.0

Source: Environment Canada, *Canada Water Year Book 1981-1982*.

And, finally, one important side-effect of these anticipated changes in dryland agriculture is that they should also reduce the public pressure for more irrigation on the Prairies. Under this scenario, irrigation, ceterus paribus, would effectively become a relatively less profitable on-farm intensification option.

4.2.2 Water Rights

Water rights are the fundamental non-market regulatory mechanism presently utilized to allocate water, both between sectors and within the agricultural sector.

In Alberta at least, water rights give irrigation farmers a quasi-legal right to 1.5 acre-feet of water per acre, irrespective of how efficiently it is used. It is analogous to a non-transferable production quota. It cannot be bought, sold, or traded. It cannot be disassociated from the "assessed" irrigable acreage in question. As such, there are no built-in incentives to encourage water use adjustments (or efficiencies) over time.

Perhaps the single most effective policy change required to facilitate more efficient water use in agriculture would involve making all water "quotas" terminable and/or transferable between farmers (land parcels), subject to District approval.

The nature and extent of the efficiencies which could be secured by this institutional change are, however, unknown. An analysis of efficiency differences between transferable and non-transferable quotas in, say, the dairy industry would be instructive.

A more extreme change would challenge historic riparian law whereby water rights are allocated (in practice, for perpetuity) successively to those who put water to a "beneficial use". For example, to reestablish public "ownership" over socially

TABLE 4.2

SUMMARY OF PROJECTED DRYLAND CULTURAL PRACTICES AND IMPLICATIONS FOR WATER USE ON THE PRAIRIES, 1985 - 2000

Item	Brown and Dark Brown Soil Zones		Black and Other Soil Zones	
	Summary Description	Impact on Water Use	Summary Description	Impact on Water Use
Cropping Patterns	Minor increase in crop rotation length; increased special and pulse crop production	Positive impact from the aspect of diversification and stability of summerfallow crop yields	Significant increases in crop rotation length; increased special and pulse crop produciton	Diversification will mitigate drought; decrease in summerfallow could accentuate drought in Thin Black soil zone
Tillage	Decreased tillage; substition of chemicals for weed control; more combined operations at seeding	Positive effect when coupled with innovative harvesting and snow trapping techniques	Decreased tillage; substitution of chemicals for weed control; more combined operations at seeding	Positive effect
Harvesting	Increased standing stubble height; improved distribution of straw and chaff; increased grain drying; decreased burning	Positive effect when coupled with reduced tillage; reduced risk of crop loss due to grain drying	Increased standing stubble; improved straw management; decreased burning	Positive effect
Fertilizer Practices	Major increases in cropped area treated; minor increases in rates; increased banding at expense of broadcast incorporation methods	Positive impact; increased drought tolerance of crops	Major increases in cropped area treated; minor increases in rates; increased banding at expense of broadcast incorporation methods	Positive impact; particularily in Thin Black
Weed Control Practices	Minor increases in herbicide coverage and areas treated with more than one chemical	Positive impact on productivity; decreased competition during critical dry period	Minor increases in herbicide coverage and areas treated with more than one chemical	Positive impact on productivity, decreased competition during critical dry period
Crop Genetics	Minor increases in drought tolerance of recommended crop varieties	Positive impact	Minor increases in drought tolerance of recommended crop varieties	Minor impact in Thin Black; no impact in Other zones

Source: Adapted from darWall Consultants (1983) Historic Trends, Drought and Cultural Practices Study Element No. 8, Saskatchewan Drought Studies, Regina.

questionable water diversions for any purpose (at the expense of other uses), legal recourse to the "public trust" doctrine might be desirable:

> "Dating back to Roman times, (this doctrine) asserts that governments hold certain rights in trust for the public and can take action to protect them from private interests. Its application has potentially sweeping effects since even existing water permits or rights could be revoked in order to prevent violation of the public trust." (Postel, 1984)

Water rights are a provincial responsibility. Nevertheless, federal initiatives could at least encourage study of the social, economic, environmental, and legal ramifications of changes to existing water rights legislation in Canada.

4.2.3 Water Delivery Systems

Delivery systems must be considered at two levels: **off-farm (District) systems,** and on-farm irrigation systems. The efficiency of each can be measured by looking at **water conveyance efficiencies** and **farm water application efficiencies** respectively.

Regarding existing off-farm water conveyance efficiencies, Table 4.5 is suggestive. An average conveyance efficiency of 60 percent is characteristic of irrigation on the Prairies. Yet a good quality open conveyance system should result in an 80 percent efficiency level; virtually 100 percent for pipe. Eight-100 percent conveyance efficiency levels would, by definition, deliver 20-40 percent more water to the farm gate.

The socio-economic payoff to efficiency improvements of this magnitude is relatively high. Moreover, the relative socioeconomic benefit-cost (B/C) ratio for irrigation rehabilitation is generally better than the corresponding B/C ratio for new projects.

TABLE 4.3

CANADIAN AND PRAIRIE AGRICULTURE, 1981

	Canada	*Prairies*
Total number of farms	318,361	154,816
Number of farms with sales of $2500 or more	271,604	142,023
Number of farms: wheat[1]	55,780	54,579
Number of farms: small grains[1]	52,086	35,188
Improved Area (million hectares)		
Under crops	31.0	24.6
Summer fallow	9.7	9.5
Pasture	4.4	2.9
Total[2]	46.1	37.7
Improved area per farm (hectares)	144.9	243.6
Cropped Area (million hectares)		
Wheat	12.4	12.1
Barley	5.5	5.0
Other grains[3]	3.7	1.9
Total grains	21.6	19.1
Rapeseed	1.4	1.4
Other oilseeds[4]	1.0	0.7
Total Oilseeds	2.4	2.1

Notes: [1] Farms with sales of $2,500 or more, by major product sold
[2] Including other improved land uses
[3] Oats, mixed grains, corn, rye, buckwheat
[4] Flaxseed, soybeans, sunflowers, mustard seed

Source: Statistics Canada, *1981 Census of Canada*

Some empirical evidence for the South Saskatchewan River Basin (Oldman River), each developed using an identical methodology, is illustrative: (Marv Anderson, 1983a)

```
Rehabilitation:   ID No. 1......B/C = 2.2
                  ID No. 2......B/C = 1.9

New Development   Option 1...B/C = 1.2
                  Option 2...B/C = 1.3
                  Option 3...B/C = 1.4
```

More recently public hearings re-affirmed that:

> There was complete agreement... that rehabilitation of existing conveyance structures and facilities was the highest priority in the development of irrigation in southern Alberta [because of] the additional water that would be available if transmission losses were reduced and [because of] the reduction in seepage and the consequent reduction in salinization. (ECA, 1979)

This ignores distributional questions.

With respect to environmental impacts, our tentative conclusion would be similar. The net impact should be more positive for rehabilitation than for new irrigation development on more marginal lands.

Again, however, the jurisdictional ramifications do not make this choice so obvious. Provincial and federal cost sharing agreements in both Alberta and Saskatchewan, at least, are generally more favourable for major irrigation structures (such as new reservoirs and main canals) than for Irrigation District rehabilitation. From a socioeconomic and environmental perspective, this is perverse.

At the farm level, water application efficiencies are heavily dependent upon both the method of irrigation and on the way the irrigation system is managed.

Surface irrigation systems of the border and contour ditch type were the earliest

TABLE 4.4

IRRIGATION IN CANADA, 1971 and 1981

Province/Region	No. of Farms*			Irrigation Farms as % of Total Farms	Irrigated Area (ha.)			Irrigated Area as % of Total Improved Land
	1971	1981	% Change		1971	1981	% Change	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Newfoundland	8	n.a.	-	1.2	50	n.a.	-	0.5
P.E.I.	17	n.a.	-	0.5	219	n.a.	-	0.1
Nova Scotia	160	n.a.	-	3.2	755	n.a.	-	0.4
New Brunswick	138	n.a.	-	3.4	1,267	n.a.	-	0.2
MARITIMES	323	-	-	2.5	2,291	-	-	0.4
QUEBEC	2,418	n.a.	-	5.0	37,609	n.a.	-	1.6
ONTARIO	3,880	n.a.	-	4.7	40,272	n.a.	-	0.9
Manitoba	151	283	87%	1.0**	2,968	6,935	134%	0.1**
Saskatchewan	918	1,277	39%	1.9**	31,372	55,913	78%	0.3**
Alberta	3,678	4,159	13%	7.2**	217,539	393,969	81%	3.1**
PRAIRIES	4,747	5,919	25%	3.8**	251,879	456,817	81%	1.2**
B. C.	5,794	6,706	16%	33.5**	89,468	100,475	12%	10.6**
C A N A D A	17,162	n.a.	-	5.4***	421,519	n.a.	-	0.9***

* Number of farms with at least some irrigation.
** In 1981. All based on farm numbers and farmland areas in 1981.
*** In 1971. Based on farm numbers and farmland areas in 1981.

Source: Statistics Canada, Census of Agriculture, 1971 and 1981.

to be used. As the irrigated area increased and greater efficiency was required, border dyke and furrow systems came into use. Sprinkler irrigation has become increasingly popular over the past 20 years with the major shift to these systems occuring in the period 1960-64. Now about two-thirds of Prairie irrigation is irrigated by sprinkler systems (about one-half of which is center pivots) and one-third is irrigated by surface systems. Sprinkler irrigation is used mainly for the irrigation of intensive crops such as sugar beets, green peas, potatoes, and some cereal grains. Surface irrigation is more typical for pasture, forage crops, and cereals.

The resulting on-farm efficiency rates are presently about 50 percent (Table 4.5). A further shift to sprinkler (and drip) systems would result in still higher on-farm water application efficiency levels.

But most irrigation experts agree that the actual efficiency of water use obtained in the field depends as much on the way the irrigation system is managed as on the type used. Although drip irrigation may be inherently more efficient by design, the wide average range of efficiency for each system--40-80 percent for gravity flow, 75-85 percent for a center pivot sprinkler, and 60-92 percent for a drip system--shows that management is a key determinant. Farmers using conventional gravity-flow systems, for example, can cut their water demands by 30 percent by capturing and recycling the water that would otherwise run off the field. Some U.S. jurisdictions now require these tailwater reuse systems while many U.S. farmers who pump water from aquifers find that a tailwater reuse system is less expensive than pumping additional well water (Postel, 1984).

In Canada, with a low cost (to the farmer) supply of surface water assured at the farm gate, the economics are different; the economic incentives to use water more

TABLE 4.5

ESTIMATED IRRIGATION EFFICIENCIES FOR SELECTED IRRIGATION DISTRICTS IN ALBERTA, 1978

District	Delivery Efficiency::	Farm Efficiency::::	Irrigation Efficiency::::::
	....	percent	....
SMRID West	53	50	27
SMRID East	77	50	39
LNID	60	44	26
TID	72	58	42
RID	45	40	18
MID	45	40	18
UID	40	35	14
Aetna, Mountain View, & Leavitt Districts	40	35	14
OLDMAN RIVER BASIN (average)	64	49	31

:: The ratio (or percent) of the volume of water delivered at the farm headgate, by an open or closed conveyance system, to the volume of water delivered to the conveyance system at the supply source(s). Also termed "water conveyance efficiency".

:::: The ratio (or percent) of the volume of irrigation water transpired by plants plus that evaporated from the soil plus that necessary to maintain a favourable salt content in the soil solution, to the volume delivered. Also termed "water application efficiency".

:::::: The ratio (or percent) of the volume of water that is beneficially stored in the root zone to the volume of water initially diverted or stored for irrigation. It is the mathematical product of the water application efficiency, the water conveyance efficiency, and (if applicable) the reservoir storage efficiency.

Source: Stanley/SLN Consulting, Oldman River Basin Irrigation Studies, Summary Report, Alberta Environment, Edmonton, 1978, pp. 4-5.

efficiently on the farm are less pronounced.

The net result is that about one-half of the water diverted for irrigation is presently lost to agriculture. It is withdrawn but not consumed (Table 4.1).

This, however, may overstate on-going "losses". If we recognize that return flows to natural systems are not real "losses" and further calculate that return flows account for 15 to 20 percent of the traditional "efficiency" loss, then estimated efficiency levels are somewhat higher, say 60 percent (Table 4.6).

This logic can be questioned. But what is irrefutable is that **higher water use efficiencies in agriculture will not likely release water for other uses.** Indeed, just the opposite outcome would be expected and less water would actually reach potential downstream users.

In short, the socio-economic benefits of higher water delivery efficiencies are largely intra-sectoral. Efficiency gains by existing irrigators might also moderate the demands for further irrigation development because existing water supplies will subsequently irrigate more land (or the same land more intensively). On the other hand, greater irrigation efficiencies will increase the profitability of irrigation vis-a-vis dryland and this, in turn, would tend to increase the demand for more water for additional irrigation development on existing drylands.[1]

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[1] The development process in Israel is illustrative. Through the widespread adoption of sprinkler and drip systems and excellent management, the average volume of water applied per hectare declined by nearly 20 percent between 1967 and 1981, allowing the nation's irrigated area to expand 39 percent while irrigation water withdrawals rose by only 13 percent. (Postel, 1984)

TABLE 4.6

DISTRICT IRRIGATION WATER EFFICIENCIES IN THE ALBERTA PORTION OF THE SASKATCHEWAN-NELSON BASIN (%)

Year	Overall Diversion Efficiency $\frac{Wcu - Pr}{Dg}$	Effective Efficiency $\frac{Wcu - Pr}{Dg - Fr}$
1951	33.10	122.54
1956	55.41	80.78
1961	42.83	61.56
1966	39.72	85.44
1971	44.29	59.62
1976	47.35	62.60
1977	45.81	58.67
1978	32.05	46.84

Overall diversion efficiency = $\frac{Wcu - Pr}{Dg}$

Effective efficiency = $\frac{Wcu - Pr}{Dg - Fr}$

where Wcu = crop consumptive use values

Pr = precipitation from May 1 to September 30

Dg = gross water diversion to the District

Fr = return flow from the District

Source: Alberta Environment (1982) Prairie Provinces Water Board, Water Demand Study, Agricultural Water Uses--Alberta Planning Division, Edmonton

4.2.4 Water Scheduling

Like water delivery systems, water scheduling has both an off-farm and on-farm component.

The objective of improved scheduling is to adjust water withdrawals considering actual weather conditions, evapotranspiration rates, soil moisture, and crop water requirements.

Most Irrigation Districts in Canada have managers and "ditch riders" to regulate flows through the system. For major systems, proper scheduling is a complex and increasingly sophisticated process. When it takes, say, a week for water to go from the main turnout to the last farmer at the other end (like the large St. Mary Irrigation District in S. Alberta), proper scheduling becomes especially critical.

Proper scheduling has two payoffs: (1) it results in water savings, and (2) irrigating precisely when it is required (before the crop is under stress) increases crop yields substantially. Proper scheduling can reduce water needs by 20-30 percent yet increase yields by a similar percentage (Postel, 1984).

Both system and on-farm scheduling can be improved further by using computerized water balance models, computerized models to estimate crop water requirements, and telephone "hotlines". In Canada, however, this level of sophistication is still in its infancy.

4.2.5 Pricing and Metering

Perhaps no other water-related topic has received so much attention by resource economists. An extensive literature review was completed by Marv Anderson and

Associates (1978b).

Yet what most of these studies establish is a price elasticity of demand for irrigation water; not the expected socioeconomic benefits and costs of actually increasing the real price of water to manage this resource more effectively. Economists in general seem to simply assume that this socio-economic payoff would be considerable. This, however, is not readily apparent--perhaps, in part, because so few irrigation authorities have actually experimented with price adjustments to try to regulate demands.

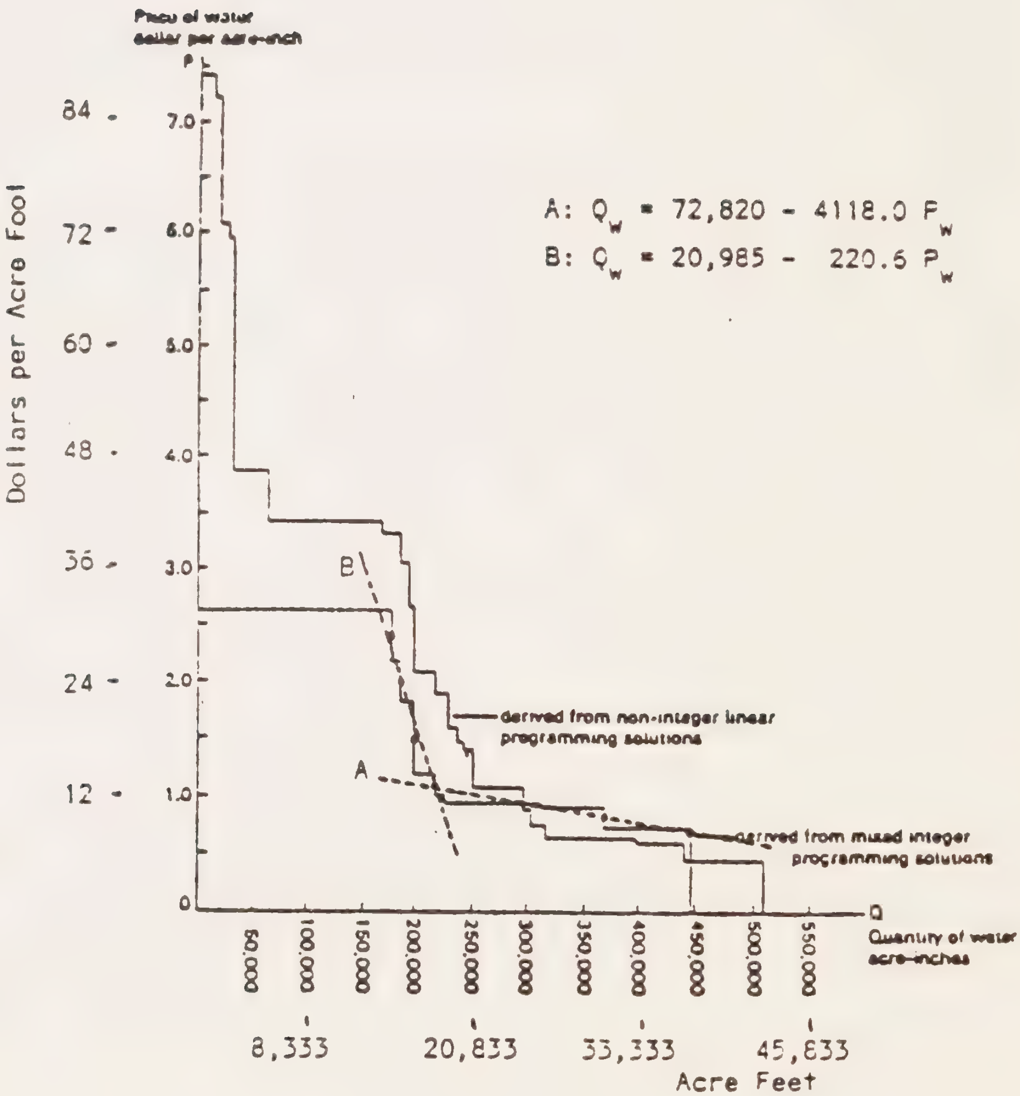
Price rigidities may, in fact, be almost imperative, ceterus paribus, because of the structure of the agricultural industry itself. In agriculture, there is a strong tendency for the residual "profits" from various factors of production to be quickly capitalized into the value of the land (PFRA, 1984b). If, in fact, this is true, then water prices may really only be flexible with respect to new irrigation.

Nevertheless, the potential for using an effective price to allocate limited supplies of water to irrigation is still very appealing because even modest water price increases (i.e. lower implicit subsidies) would have a very major impact on how water is used particularly on the Prairies. In part, this is because there is a pronounced "kink" in the demand curve for irrigation water in Western Canada, as illustrated in accompanying Figure 4.2 (i.e. Section A is much "flatter" than Section B). The reason for this "kink" can be traced to the use of water on marginally profitable low-value crops which would no longer be profitable to irrigate with even very modest water price increases (Marv Anderson, 1978b).

With adequate markets for higher-valued crops (so cropping patterns would change), this might/might not actually "save" water. This would depend upon the

Figure 4.2

"STEPPED" AGGREGATE DEMAND CURVE FOR IRRIGATION WATER (MANITOBA FARMS)



Source: W. J. Craddock (1971) "Linear Programming Models for Determining Irrigation Demand for Water", Canadian Journal of Agricultural Economics Vol. 19, November.

consumptive water requirements of the new versus old crop mix. But at the very least, there would be a net social gain (via lower implicit subsidies) and net returns to farmers with irrigation would climb.

A more politically palatable policy might simply involve water metering and effective water quotas, given a flat rate (and inflexible) price structure. There is at least some evidence to suggest that water metering alone might result in water savings of 10 or 20 percent. At this juncture, however, even the effective metering of irrigation water in Canada is not widespread.

Augmenting water prices and/or metering would also stimulate further improvements to water delivery systems which, in turn, would reduce seepage and salinity accumulations along existing canals. But too little water could also limit the on-farm opportunity to flush excess salts from the soil (which, of course, can also reduce the quality of return flows). The net environmental impact is obscure.

Perhaps a major reason that an effective water pricing policy is not used to regulate irrigation water demand is jurisdictional. At least in Alberta, Irrigation Districts are largely self-governing bodies, somewhat similar to municipalities or counties. Water rates are, in effect, self-imposed taxes. Here again, it might be argued that the price of a provincial-national resource should not be unilaterally determined by potential regional users of the resource in question.

4.3 Efficiency Measures: Municipal/Industrial

4.3.1 Matching Quality and Use

One reason that recognizing the concept of matching quality and use is important is because potability may be getting more difficult to assure, making such supplies

more precious. While water treatment to compensate for bacteriological problems has been quite well developed, treatment for trace toxics which are now becoming detectable has not. Perhaps of most import is that the detectability of, and the recent concern about, such toxics is likely to continue to lead both knowledge about their effects and ability to remove them (Robinson et al, 1984). One longer term implication of the trace toxic problem for demand management is that treating all municipally supplied water for potability could become much more costly, resulting in severe price increases which would affect demand.

The only alternatives are variations on the theme of matching quality and use:

a) consideration of separate provision of waters of different quality for different purposes; and/or

b) encouragement of point-of-use treatment or use of other sources, e.g. bottled water for those especially concerned about unknown effects of trace contaminants.

Any of these would have significant impacts on the water use system, including equity and safety (Robinson et al., 1984).

Another implication of our inability to routinely treat toxics is that the quality-demand relationship should be more clearly understood for residential/commercial and for industrial water users in each area. This is a prerequisite for development of emergency procedures for catastrophes, e.g., accident or sabotage rendering part or all of the supply non-potable. While some water supply systems have plans at some level for dealing with drought or unexpected low quantity, almost none have procedures for sudden problems with quality. While now rare, plans for both should be developed as water supplies are vulnerable; disasters would require the ultimate in management of demand.

Matching quality and use will become more important in Canada, and will not come about just through use of non-potable supply sources. It is also happening through industrial recycling and through re-use of wastewater and stormwater, discussed above in sections 3.3.7 and 3.6.

4.3.2 Constructing New Structures to be More Water-Efficient

While the discussion in section 3.3.3 showed that technology exists to reduce domestic consumption, such water-efficient fixtures are readily available in Canada (Anderson, 1984). Also, the cost increases for low use over conventional fixtures are small, in the range of $8-20 in 1980, and the cost savings through lower water consumption more than justify their use in specific regions (Howard-Ferreira and Robinson, 1980a). The question that remains is the method which should be used to maximize their installation where desirable.

(a) Regulation

The most common approach in such a case is that of regulation. It has been used quite successfully in many cities in the United States.

For a number of years discussions have been held with Ontario government staff and associated agencies re the implementation of regulations that would encourage the use of water efficient plumbing fixtures because the province has regulatory jurisdiction. In 1977, almost all major municipalities requested that the Ontario Water Resources Act Regulation 647 (plumbing regulations) be amended to accommodate needs of local municipalities desiring water efficiency. Such an amendment would provide at minimum for an alternate set of regulations which could apply to specific areas where water use was a significant concern.

However, the Province did not act at that time on the rationale that such a move might spur a revision back to the pre-1952 era when each municipality had its own plumbing code. One specific concern was that uniform provincial regulations improved efficiency in the building industry by facilitating mobility of trades. Another was that the existing regulations were developed for health and safety objectives only, not for economic or other objectives, and thus any such change would require a new philosophical base for them.

Since then, discussions have also been held with the Canadian Standards Association (CSA) and three large domestic toilet manufacturers. A request was made that the manufacturers post the flush volume of their products on the CSA certification sticker in a similar fashion to that used to indicate the energy consumption of appliances. This approach was rejected initially as the manufacturers were concerned that flush volume not become a basis for customer purchase decisions. At subsequent meetings, however, it was agreed that those water closets advertised as being "water-efficient" would be tested by the Certification Division of CSA as to whether they met a "water conservation standard". An amendment to the CSA B-45 series of standards provides for certification of water closets as "conservation type" providing they do not use more than 13.25 litres per flush. This is a mid-range limit which many current water closets could reach (CSA, 1984).

However, although Canadian standards for "conservation type" or water-efficient toilets now exist, there is as yet no legal means provided by the provincial government, or available to local or regional municipalities, to require their installation in any region (Howard-Ferreira and Robinson, 1980a). In the absence of such means, there is no straight-forward approach in areas where such fixtures should be used for water-efficiency or economic reasons.

(b) Incentive Program

The Regional Municipality of Waterloo in 1981 approved funding for a program providing a $75.00 rebate for each newly constructed dwelling in which water-efficient fixtures were installed. The dwelling had to be supplied by public water distribution and wastewater collection facilities. Implementation did not begin until late 1984 after development of detailed procedures and a catalogue for identification of qualifying water-efficient fixtures.

While such a program may be considered desirable in that it retains a voluntary complexion, it could not have been implemented without the goodwill and substantial cooperation among the politicians and staff of the several local municipalities and of the Regional Municipality of Waterloo. Such goodwill and cooperation may not be present in all regions where action is desirable.

The effect of the program in changing the mix of fixtures installed remains to be seen.

4.4 Summary of Water Use Efficiency Improvement Potential

In the absence of market or non-market constraints to improved water use efficiencies, the potential productivity gains in the agricultural sector are enormous:

Dryland Cultural Practices	15% X 40 M hectares
Water Delivery Systems:	
Off-Farm	25% X 500,000 ha.
On-Farm	25% X 500,000 ha.
Water Scheduling	25% X 500,000 ha.
Water Pricing	Unknown
Water Metering	15% X 500,000 ha.

Note, in particular, that this would essentially double irrigated production, given existing water supplies.

Thus:

1. Water demand management policies which focus on improving water use efficiencies in agriculture would, almost by definition, translate into more efficient, more profitable farming operations in Canada.
2. Further, it would allow for considerable irrigation expansion (or intensification) with existing water supplies.
3. In addition, this should moderate the **short-run** demands for water for irrigation.
4. At the same time, water "savings" to accommodate other potential water users are not envisioned.

The anticipated effects of demand management measures on municipal and industrial use are summarized in Table 4.7.

Table 4.7 Summary of Water Use Efficiency Potentials:
Municipal and Industrial Measures
(Based on Experiential Data)

Measure	Change	Percent (Max)	References
A. Short-Term Measures			
1. Leak detection and maintenance	Reduce line losses	(40)	Tate, 1984
2. Metering	Reduce residential total use (small municipalities)	(13-20)	Loudon, 1984
	Reduce residential outdoor use	20	USHUD, 1984
3. Rate structure modification			
a)user pay policy, including sewer surcharge	Reduce total use	33	Loudon, 1984
b)user pay policy, adding excess use charge	Reduce maximum day demand	12.5	Griffith, 1984
4. Retrofitting	Reduce residential use where installed		
a)Toilet + shower devices 75% retention	(N.B. also energy savings)	5.5-8.8	USHUD, 1984
b)Stop toilet leaks		(42)	USHUD, 1984
c)Shower + faucet device, stop toilet leaks	(N.B. also energy savings)	(65)	USHUD, 1984
5. Regulation of water pressure	Reduce residential use, high pressure areas (> 625 kpa)	6	USHUD, 1984
6. Insulated/heat traced services	Reduce use, northern communities	(50)	Robinson et al., 1984
7. Recycling	Reduce use/unit output		
a)individual firms		(94-97)	Postel, 1984; Krueger, 1984
b)nationally		(75)	Postel, 1984
B. Longer Term Measures			
1. Pressure regulation	Reduce use, new residential/ commercial development, high pressure areas	(6)	USHUD, 1984
2. Water-efficient new structures	Reduce use, new residential development		
a)Low flush toilets			
i)North American [A] (13.25 l./flush)		14	USHUD, 1984
ii)European (9 l./flush)		21	
b)Low-flow showerheads [B] (11.4 l./min.)	(N.B. also energy savings)	13	USHUD, 1984
c)Low-flow faucets		0.88	AWWA, 1981
d)Low flush toilets [A] + low-flow showerheads [B]	(N.B. also energy savings)		
i)single family		23	USHUD, 1984
ii)multiple family		29	USHUD, 1984
3. Water-efficient appliances	Reduce residential use at rate of turnover + new installations		
a)Clotheswashers		3.0	USHUD, 1984
b)Dishwashers		1.8	USHUD, 1984

V. OBSTACLES AND OPPORTUNITIES

5.1 Obstacles

The principal obstacles to developing a more broadly-based water demand management strategy generally have a social-political dimension.

1. The fundamental constraint is that greater efficiencies (as employed in the proceeding) are only one of many objectives in the policy-making process. In fact, in the politics of water the active political players are not really interested in relative total social costs and benefits. What is important to them is the distribution of costs and benefits of a particular policy option:

> ...from the perspective of interests in the project area,...it does not matter if national economic benefits are less than costs. Interests in the project area focus upon the benefits that are heaped on their locality and ignore the costs which are distributed to a diffuse national [or provincial] public (Martin, 1982, p. 130).

In other words, in this context regional or sectoral **equity** considerations take precedence over **efficiency** considerations. They are preoccupied with the longer-term distribution of wealth. Physical possession of water supplies is the ultimate prize: "Possession is nine-tenths of the law." And then quickly establishing artificially high use-levels (via built-in inefficiencies and perverse pricing) effectively acts as a hedge against even higher potential water requirements in the future: "Use it or lose it."

2. Related to (1) is the fact that agricultural communities (including public and private "support services") with potential access to irrigation have a fundamental "water-is-different" philosophy. Water is believed to give rise to a Midas Touch, creating wealth and guaranteeing a prosperous future wherever it is present in ample

quantities:

> "...there are a number of opportunities across the Prairies for expanded development of water supplies...The process of removing these constraints can contribute to economic activity and employment within the Prairie region and throughout Canada. The infrastructure installed by a policy of water development can create opportunities for future generations of Canadians" (PFRA, 1984b)

And this is undoubtedly true in a site specific or regional context, even though there is little or no evidence to support the proposition that increased water supplies augment **overall** economic growth and development (Cicchetti et al., 1975; Cox et al., 1971; Fullerton et al., 1975; Kelso et al., 1973; Rivkin-Carson, 1973). The similar assumption that continued economic growth would require increased energy consumption has already been proved false since 1973.

Once again the issue here is the structure of development and, hence, ultimately, the distribution of wealth and power.

3. Historically, water has been an inexpensive commodity and even the marginal cost of new supply has been quite low; supply augmentation seemed the obvious answer.

For the manufacturing industries that use a great deal of water--primary metals, chemicals, food products, pulp and paper and petroleum--the cost of water is rarely more than 3 percent of total manufacturing expenses. Incentives to use water more efficiently have come either from strict water allocations or stringent pollution control requirements (Postel, 1984, pp. 42-43).

4. While a supply management approach tends to lead to decisions favouring system expansion, bias toward such decisions have a deeper base than the management approach. Occasionally, a large visible facility, even if more costly, may be

preferred by politicians over improving management, which may be less visible. Such a facility has the added advantage of the capability of being used to honour a politician (Tate, 1984).

Additionally, payment for implementation of many demand management measures would be allocated to a water manager's operating budget which is often pressured by politicians in an attempt to reduce rates and taxes in the short term. Projects which can be capitalized may be more readily approved.

Provincial subsidies are frequently available for capital projects while programs to reduce the need for such projects must all be funded locally. This provides additional incentive for decision-makers to favour a system expansion.

A number of demand management measures require metering of use as a basic prerequisite. However, most regulators, e.g. provincial governments, have not exercised their authority to require installation of water meters in municipalities.

5. The institutional separation of functional responsibilities for the various subsystems can make integrated management almost impossible without a high degree or cooperation. And this level of cooperation generally has not been forthcoming yet.

It is in this context that we can briefly address how the federal government might encourage greater application of water demand management in Canada.

5.2 Federal Initiatives

The list of federal initiatives which might be proposed in the above context is almost endless. We will briefly discuss seven practical policies or policy changes which would, in our professional judgement, greatly enhance water-use efficiencies in Canada.

These include the following:

1. In-house institutional reform
2. Re-focus technical support services
3. Research-Extension/Education
4. Revision of cost-sharing programs
5. Improved public information services
6. Income tax incentives
7. Reducing residential use: water-efficient fixtures, and
8. Inter-governmental support

5.2.1 In-House Institutional Reform

The Inland Waters Directorate of Environment Canada, (IWD), has responsibility for water management in five main areas: water data and monitoring, international relations, ambient water quality measurement, water planning, and research (EC, 1977).

While it is recognized that other agencies are involved, the IWD is the principal national water planning agency in Canada. Their role should therefore be expanded in line with section 5.2.5 following.

Closer coordination of water-related activities between Energy, Mines and Resources, Environment Canada, Indian and Northern Affairs, and Agriculture Canada is also highly desirable (Agriculture Canada, 1984). From a national perspective, resource use must be examined in a global context, especially land and water. This is particularly apparent when one considers current inter-related soil degradation issues (Ed Braun et al., 1984; Senate of Canada, 1984).

The important point here is that the federal government already has the power (i.e., potential policy instruments) to alter the long-term structure of industrial/agricultural production throughout Canada. This applies to both production (e.g., grain quota and grain stabilization programs) and resource use (e.g., fuel taxes).

By affecting the long-term economic structure of the economy, the demand (consumption) for water will also be affected because industrial/agricultural water demands are, in effect, a derived demand. In the longer-term, this represents sufficient leverage to greatly affect total water consumption requirements, even in the absence of direct controls over the water resource per se.

5.2.2 Re-Focus Technical Support Service

Federal technical support services have generally been characterized by a very pronounced bias in favour of engineering services. This is best exemplified by Prairie Farm Rehabilitation Administration (PFRA) expenditure patterns where Soil and Water Conservation Technical Services are still in their infancy (Table 5.1 and Figure 5.1).

In addition, PFRA essentially volunteers its engineering services to provincial governments on the Prairies for the purpose of investigating the technical feasibility of newly proposed water supply schemes in the Province(s) in question. The underlying wisdom of this rather indiscriminate policy might also be re-examined. (Also see section 5.2.5 following.)

5.2.3 Research and Extension-Education

It has been documented well in agriculture that the socioeconomic payoff to research is relatively high, often much higher than the return to other investments (Table 5.2). Some isolated success stories indicate even higher annual returns to research are possible. For example, canola research in Canada during 1960-1975 reportedly yielded a 95-110 percent return per annum (Nagy and Furtan, 1977). At least two dozen other studies on the return to agricultural research (which all document relatively high payoffs) have been catalogued (Evenson, 1979).

TABLE 5.1

PFRA EXPENDITURES AND REVENUE, BY ACTIVITY

	1980-81	1981-82	1982-83
Expenditures			
Headquarters Analysis, Planning and Program Development	$ 1 760 548	$ 1 747 026	$ 1 624 072
Headquarters Administrative Services	2 024 511	2 778 254	3 259 214
Engineering Technical Services	6 686 521	7 531 597	8 647 043
Soil and Water Conservation Technical Services	—	329 060	594 415
Construction Service Operations	709 342	849 512	890 853
Water Development Program Administration	2 453 260	2 921 826	3 413 291
On-Farm Water Development	4 238 247	5 783 356	4 904 613
Small Community and Group Water Development	—	111 418	619 216
Community Pasture Administration and Operations	7 427 723	7 839 147	8 908 640
Community Pasture Improvement and Development	2 226 953	1 572 414	1 488 212
Tree Distribution	2 000 071	1 812 048	2 325 691
Demonstration Farm	147 259	180 759	544 509
Agricultural Service Centres	2 359 976	2 382 797	1 076 782
Water Development and Drought Proofing:			
Manitoba Agreement	173 277	1 589 411	914 882
Saskatchewan Agreement	924 902	1 715 301	3 007 394
Southwest Saskatchewan Irrigation Projects	1 040 293	1 198 241	1 532 749
Alberta Irrigation Rehabilitation	717 239	178 720	60 868
South Saskatchewan River Project	191 235	320 054	367 149
Community Water Projects Program	24 083	35 949	10 233
Assiniboine River Diking	237 611	74 043	35 217
Herd Maintenance Assistance Program Administration	1 057 860	230 249	—
Herd Maintenance Assistance Contributions	42 887 046	2 093 436	—
Emergency Water Supply Program	311 744	490 275	—
	$79 599 701[2]	$43 764 893	$44 225 043
Revenue			
Community Pasture Operations	$ 5 967 088	$ 6 912 965	$ 8 448 147
Southwest Saskatchewan Irrigation Projects	225 311	197 356	215 919
General Revenue	3 393 914	3 320 725	2 792 251
	$ 9 586 313	$10 431 046	$11 456 317

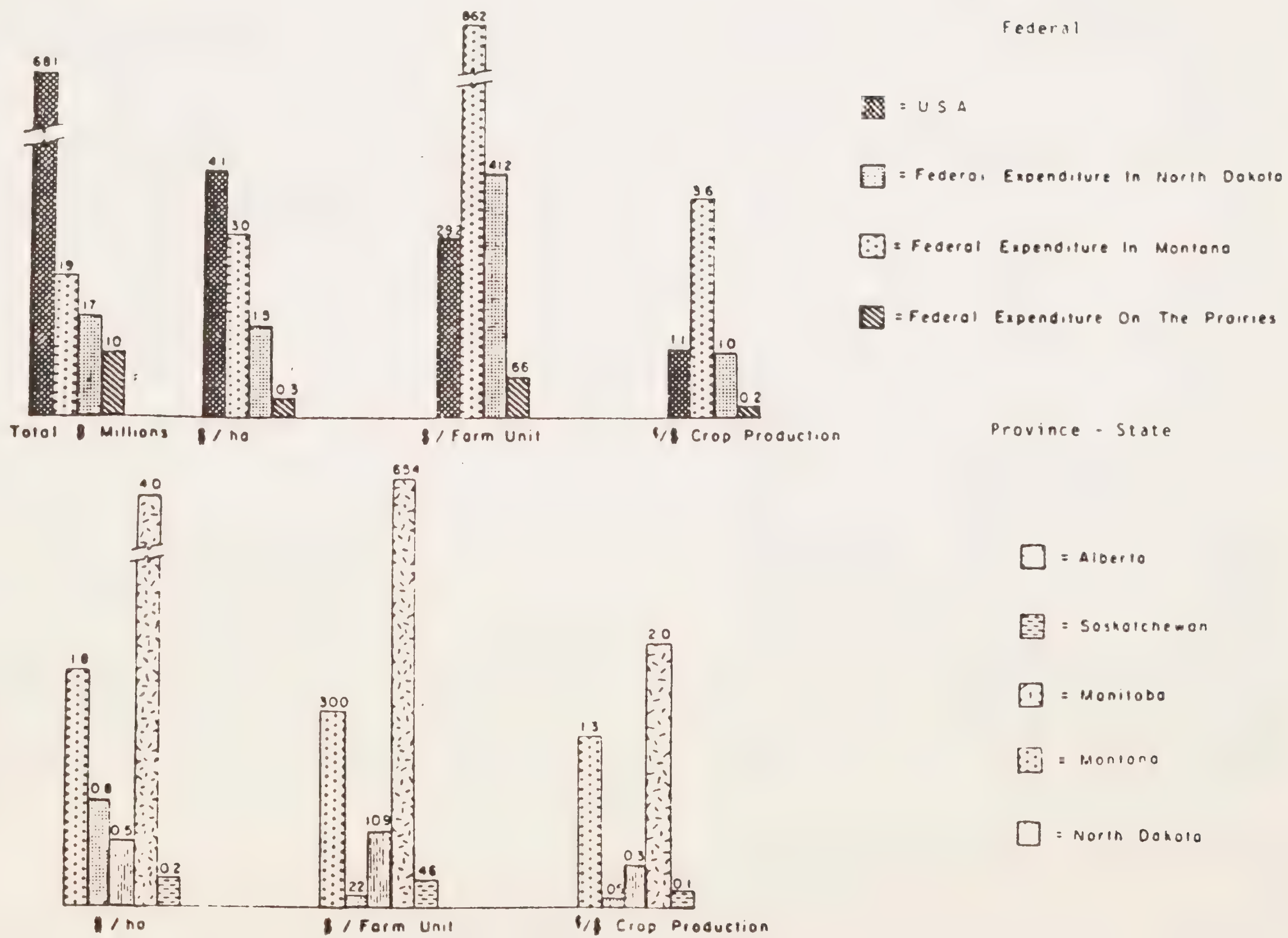
[1] Includes operational expenditures, capital expenditures and contributions

[2] Does not include write-off of working capital advance $513 739 in fiscal 1980-81

Source: PFRA (1984) Annual Report, 1982-83 Agriculture Canada, Ottawa. Appendix 1, p. 18.

FIGURE 5.1

COMPARATIVE FEDERAL, PROVINCIAL AND STATE EXPENDITURES
ON SOIL AND WATER CONSERVATION 1979



Despite its evident value, very little research has been conducted in Canada on water demand management. A major factor contributing to this is that the federal research budget available for such work is low and has been effectively declining

Table 5.2

ESTIMATED RETURNS FROM INVESTMENT IN ALL

AGRICULTURAL RESEARCH IN THE UNITED STATES

Investigator	Year	Period	Annual Return (%)
Peterson and Fitzharris	1977	1937-1942	50
		1947-1952	51
		1957-1962	49
		1957-1972	34
Griliches	1964	1949-1959	35-40
Evenson	1968	1949-1959	47
Lu and Cline	1977	1938-1948	30

Source: R. E. Evenson et al. (1979) "Economic Benefits from Research: An Example from Agriculture", **Science** Vol. 205, No. 4411, Sept. 14.

annually. For example, the total budget for the Inland Waters Directorate's Water Resources Research Support program, only a fraction of which can be allocated for demand management research, has held constant at $250,000 since the late 1970's. In addition, the work of the Inland Waters Directorate's two research institutes has not addressed this area of research.

Clearly, more funds are needed to stimulate research in this area, even if they only are used to match research expenditures on demand management by lower levels of government.

Such research should investigate not just the effects on reducing water use, but also the broader questions of **all** beneficial and adverse effects.

In the municipal and industrial sectors, research on the effects of policy changes and of technological modifications in the Canadian context are needed. The potential

for recyling technologies in Canadian industry needs to be examined and documented to assist in policy development. Further research is also needed on practical re-use possibilities for wastewater and for collected stormwater. One basis for federal involvement in such research is the potential for reduction of pollution of the Great Lakes.

One area of demand management needing particular attention is the development of Canadian research and experience on rate structure alternatives better reflecting costs of supply and on how to successfully implement such rate changes (i.e. the practice as well as the theory). Dissemination of this information, and information on metering, is required not just to water managers, but also to decision-makers and especially to the general public who have had little or no experience with significant real changes in the cost of water (DeYoung and Robinson, 1984).

In agriculture, funding both for research and for extension-education with a well-defined focus on water conservation is required. This long-term program would key on some of the more prominent on-farm water-saving technologies, some of which are still in their infancy, including:

--improved irrigation scheduling

--improved irrigation technologies for Canada

--minimum tillage

--use of stubble mulches

--improved snow management

--drought-resistant crop varieties (cereals and forages).

Each research component would ideally have its extension-education counterpart. This would generally be done in cooperation with provincial extension services, similar to an on-going salinity control project in south-eastern Alberta. In the longer-

run, this would greatly enhance on-farm water-use efficiency levels.

5.2.4 Revise Program Structure

This initiative would re-examine all land and water related program expenditure priorities, expenditures which generally relate to existing costsharing agreements with the respective provinces.

The historical provincial bias in favour of water supply augmentation and status quo expansion (versus demand management and expansion with structural change) is expected and widely acknowledged. (See, for example, accompanying Table 5.3) The objective here would be to re-direct some of these funds towards viable water demand management alternatives.

5.2.5 Provide Additional Support to Public Information Services

As already discussed in the preceding, the socio-political system almost makes financial-technical support for broadly-based public interest groups obligatory. This is required to counter the inherent advantages held by special interest groups. This might also involve more actively supporting provincial or inter-provincial river basin studies, particularly comprehensive planning studies such as the on-going SSRBPP.

5.2.6 Tax Incentives

In this context, numerous income tax incentives could be devised. For example, a tax credit could be offered for improving on-farm distribution systems (e.g., lining on-farm ditches) or, perhaps, for planting drought tolerant crop varieties.

Another use of tax credits might involve encouraging the multiple use of existing water supplies, e.g., farmer tax credits for slough consolidation to support waterfowl

TABLE 5.3

WATER MANAGEMENT EXPENDITURES IN SASKATCHEWAN, 1935-1980

Program/Program Category	Expenditures[b] $M 1980	Program Ranking
1. Water Augmentation		
South Saskatchewan River Irrigation Project	433	3
Individual & Neighbor Stockwater Dams, Dugouts, & Other Source Development	141	5
Southwest Saskatchewan Irrigation Projects	131	6
Farm Water & Sewage	88	8
Individual & Neighbor Farm Wells	24	15
Individual & Neighbor Irrigation Projects	16	18
Irrigation Development for Organized Groups	13	19
Sub-Total	$ 846 (33.0%)	
2. Water Conservation		
Saskatchewan Research Council	18	16
Tree Planting & Shelterbelt Program	17	17
Sub-Total	$ 35 (1.4%)	
3. Modification of Demand	nil	
4. Modification of Intra-Sectoral Characteristics		
PFRA Community Pastures	105	7
Municipal Water Assistance Boards	67	9
Association Pastures	54	10
Provincial Pastures	52	11
Ducks Unlimited	41	12
Agricultural Service Centers	41	13
Community Capital Fund	12	20
Sub-Total	$ 372 (14.5%)	
5. Spread/Share Losses & Costs		
Debt Adjustment	540	1
Prairie Farm Assistance Act	467	2
Crop Insurance	279	4
Herd Maintenance Assistance Program	26	14
Sub-Total	$1,312 (51.1%)	

[a]Based on the top twenty programs and tabulated expenditures ($ real) during 1935-80.

[b]Program category shares indicated in brackets.

Source: Marv Anderson & Associates Ltd. (1983) Catalogue of Drought Programs Study Element 15A, Saskatchewan Drought Studies, Regina, March.

habitat and hunting, or farmer tax credits to encourage the supplemental irrigation of highlands with excess water from neighboring lowlands.

5.2.7 Reducing Residential Use: Water-Efficient Fixtures

(a) Establishment of a "WATERGUIDE" Program

Such a program would be modelled on the current ENERGUIDE program (Tryfos and Fenwick, 1984) and could be implemented in cooperation with Consumer and Corporate Affairs.

Objectives of such a program would be threefold:

1. to enable purchasers to compare the water consumption of available models and to choose from comparable models the one that consumes the least amount of water:
2. to allow retailers to assist their customers in making purchase decisions based in part on the water consumption of the featured models, and:
3. to encourage fixture manufacturers to improve the water efficiency of fixtures and appliances through research, design and development.

Initially at least, the program should be based only on water closets. If successful, other fixtures and fittings could be added in the future.

One step toward this goal occurred with creation of a water conservation standard for water closets discussed above in section 4.3.2.

Such standards are desirable as an intermediate phase in helping shift purchases to models below the threshold. However, they do not serve to differentiate among fixtures meeting the standard, although as implied in section 3.3.1, there are wide

efficiency variations among fixtures meeting a low-use standard.

The ENERGUIDE program appears to have had a significant effect on domestic appliance energy consumption. (Tryfos and Fenwick, 1984, p. 52). The least efficient models disappeared from the market, but only small efficiency improvements over existing technology had occurred within the first three years of the program. The net effect in that time was to increase the market share of the most efficient models. The market by itself did not work this way until the program started. The prior problem may have been that efficiency was unrecognizable, or was not valued before ENERGUIDE, or that the market was not competitive. Nevertheless, while many other factors clearly were involved, the ENERGUIDE program is credited with a substantial proportion of the responsibility for the change (Tryfos and Fenwick, 1984, p. 59).

A WATERGUIDE program would be an ideal lead to a next step, revision of plumbing regulations, which would require some discussion and time to implement.

(b) Request the Canadian Standards Association to Develop a "Water Conservation" Standard for Shower Fixtures

While a "water conservation" standard has been developed for water closets as discussed above in section 4.3.1, and while installation of low-flow showerheads can reduce per capita consumption significantly (section 3.3.1), a complementary "water conservation" standard has not yet been developed for the latter.

While showerheads are covered in CSA Standard B125, the requirements are not very well related to code requirements for water flow and pressure in the distribution system (Beach, 1985). Development of a new standard based on flow rates and pressures is somewhat more difficult when the existing standard is not clearly

consistent internally.

Nevertheless, existence of such a standard could be used in modification of plumbing regulations (above) or in standards for an incentive program for installation of water-efficient fixtures (section 4.3.1).

(c) Revision of the Canadian Plumbing Code to Incorporate Provisions to Require Low-Use Fixtures

The Canadian plumbing code serves as a model plumbing code for the entire country. Environment Canada and the National Research Council could work to propose limitations as to where fixtures which are not "conservation type" may be used, i.e. where resource efficiency and its economic effects may be less desirable. There is precedent for this: the use of one type of water closet is already restricted (Beach, 1985). In the short term, there may be relatively few limitations. In the longer term, if concerns about water use and cost escalate, the "conservation type" might become the norm. In any case, this approach ensures that provision exists for local circumstances, yet the code remains based on CSA standards.

5.2.8 Inter-Governmental Support

Closer inter-governmental consultation and support for provincial initiatives under provincial jurisdiction is also recommended. Example initiatives are policy research with respect to:

1. Potential changes to provincial legislation governing new irrigation development, e.g., formula for farmer contributions, formula for water prices and quantities, formula for regional improvement taxes, etc.
2. Potential changes to provincial legislation governing the use of frontier lands made available to new farmers, e.g. caveats to avoid environmental

degradation. (This has a U.S. precedent in frontier agricultural areas in Alaska).

These opportunities might be particularly relevant where no legal precedents had to be overturned. That is, they would not apply to existing resource users, only to new users.

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Study Terms of Reference

OBJECTIVES

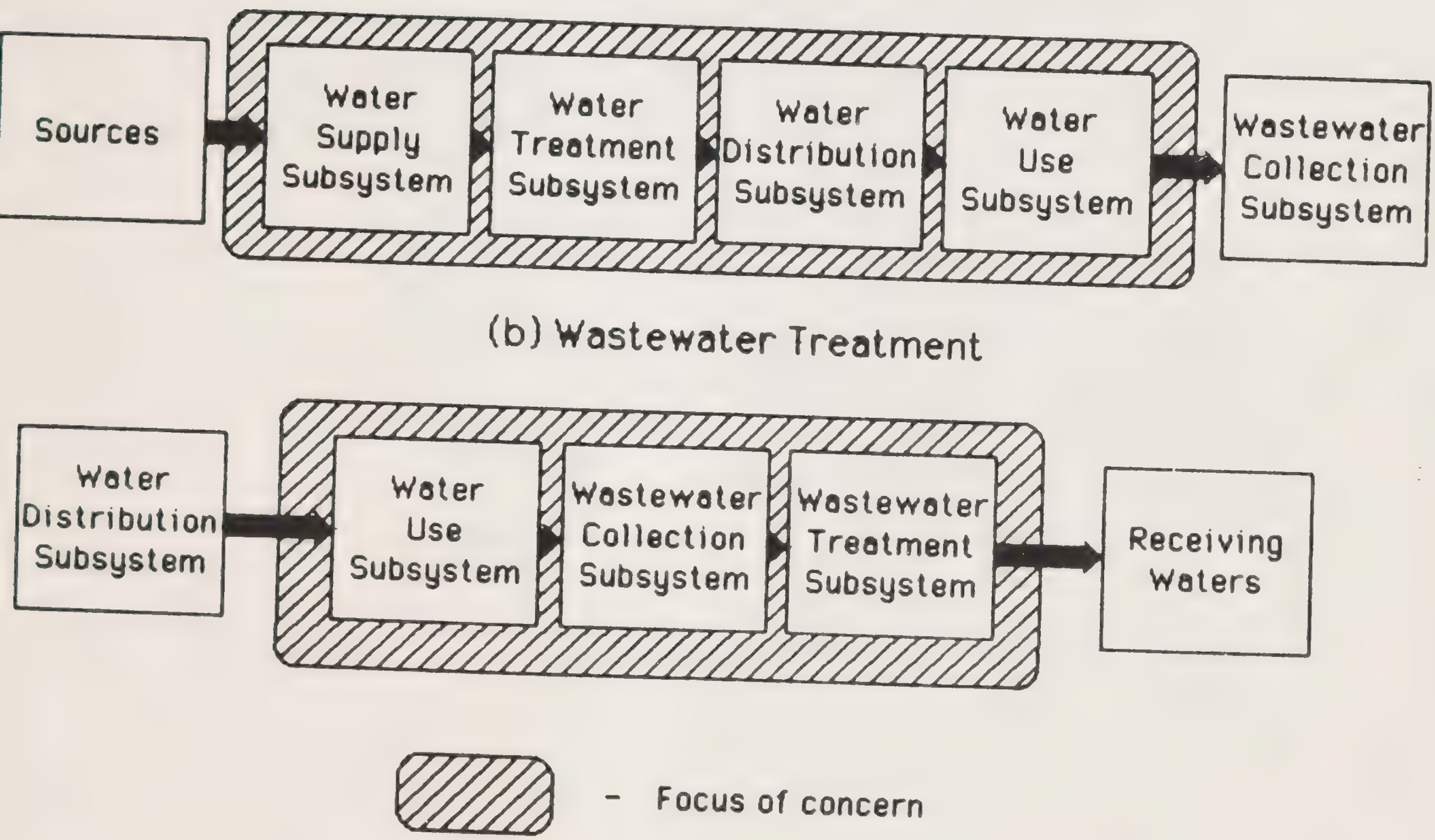
To describe existing and potential applications of demand management to municipal, industrial and agricultural water uses; and to recommend means and advantages of incorporating them more widely into Canadian water management practices.

Tasks:

1. to describe the range of demand management measures which have been or could be applied in Canada to reduce the rate of growth in water use, including measures for recycling, reclamation, recovery and reduction at source.
2. to assess the socioeconomic, environmental, and legal implications of such measures.
3. to indicate the advantages of and obstacles to integrating demand and supply-oriented water management.
4. to recommend appropriate means by which the federal government can encourage greater application of water demand management in Canada, taking into account its jurisdictional limitations.

Figure 1.3: Integrated Demand and Supply Management System

(a) Water



the clear separation of water supply and wastewater treatment as management areas no longer exists. Measures affecting the use system will have effects on both areas.

To avoid problems of suboptimality in a water/wastewater system, it can be seen that the entire system must be managed together. Figure 1.4 is illustrative of an agricultural or municipal system. It consists of at least six subsystems: water supply, water treatment, water distribution, water use, wastewater collection, and wastewater treatment. In such a system, water from various sources enters the supply subsystem and leaves from others including the wastewater treatment subsystem. From the latter it is discharged to receiving waters.

As an example of improved optimality, a measure which reduces water demand may not just avoid augmenting supply, but may defer wastewater treatment expansion as well (Howard-Ferreira and Robinson, 1980c).

In summary, demand and supply management should be integrated to avoid suboptimality, and this leads naturally to integration of water and wastewater system management as well. Integrating demand management in this way should not be seen as anti-development, but rather as focussing on rational water use, including socially beneficial reductions in consumption, and putting scarce resources to more economic use (Tate, 1984, p. 6).

1.4.3 In What Sectors is Integration Important?

Managing water demand is often associated with the residential sector, primarily due to disproportionate amounts of effort and publicity in that area. However, a review of the reasons for considering demand management (section 1.3), and of how it should be integrated in water system management (sections 1.4.1 and 1.4.2), reveals